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MEASURES OF EFFECTIVENESS FOR
RATIONALIZATION, STANDARDIZATION,
AND INTEROPERABILITY

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<p>The U.S. Army is committed to supporting national objectives to achieve greater rationalization, standardization, and interoperability (RSI) of weapons systems and equipment with our principal allies, particularly within NATO. As with other programs, the resources available for RSI activities are less than the known requirements, and RSI initiatives, therefore, must compete with other defense programs for limited funds. To facilitate the identification of those RSI initiatives that will make the greatest contribution to battlefield success and resource conservation, we have developed RSI measures of effectiveness.</p> <p>In this study, we develop measures of effectiveness for interoperability initiatives as they relate to U.S./NATO corps and army group "AirLand" battlefield operations in Central Europe; we also propose measures of effectiveness for rationalization and standardization. Specifically, we recommend (1) that improvements in effectiveness that result from communications interoperability and common logistics support be measured in terms of operational performance, personnel requirements, system costs, supporting-to-supported ratio, reconstitution capability, and satisfaction of CINCs' priorities, (2) that improvements in effectiveness resulting from rationalization and standardization initiatives be measured in terms of technology gain, acquisition time, alliance strength, economic equity in procurement, capability to conduct independent operations, and the interoperability initiatives measures of effectiveness; and (3) that RSI initiatives be evaluated under conditions that reflect coalition scenarios.</p>					
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Executive Summary**MEASURES OF EFFECTIVENESS FOR RATIONALIZATION,
STANDARDIZATION, AND INTEROPERABILITY**

Difficulties in communicating and in sharing critical logistics resources with our NATO allies are two of the most pressing issues facing U.S. Army commanders in Europe. The Army's Rationalization, Standardization, and Interoperability (RSI) Policy Office in the Office of the Deputy Chief of Staff for Operations and Plans must address these and other RSI issues by promoting initiatives to improve battlefield effectiveness and conserve resources.

Initiatives promoted by the RSI Policy Office should emphasize operational and tactical interoperability. Interoperability initiatives are those undertaken to enhance the ability of allied forces to operate together on the battlefield and ensure efficient use of defense resources. The extent to which they do so should be measured in terms of improvement in functional area performance, such as communications or refueling, personnel requirements, system life cycle costs, supporting force requirements, force reconstitution capability, and satisfaction of the stated interoperability requirements of commanders in chief.

Standardization initiatives are those undertaken to develop common tactics and doctrine, equipment, and components. As a minimum, all standardization initiatives should support interoperability of forces and systems. Effectiveness of materiel standardization initiatives in particular should be assessed in terms of technology gain and improvements in acquisition time, as well as in terms of the interoperability measures of effectiveness.

Rationalization initiatives are those undertaken to improve overall efficiency in the use of alliance resources. Effectiveness of rationalization initiatives should be assessed in terms of improvement in alliance strength, equity in the distribution of procurement expenditures among alliance members, and impact on the capability of U.S. forces to conduct independent operations, as well as in terms of the standardization and interoperability measures of effectiveness.

To provide consistency in comparing RSI initiatives affecting battlefield operations, we propose use of an RSI battlefield effectiveness improvement index. The index is the weighted sum of the interoperability measures. The effectiveness of RSI initiatives must be measured under conditions of coalition warfare and during all phases of operations: mobilization, deployment, employment, and sustainment.

The Army can significantly improve RSI policy formulation and resource allocation decision making by validating and using the proposed measures of effectiveness and the battlefield effectiveness improvement index.

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CHAPTER 1

INTRODUCTION

OBJECTIVE

This study develops measures of effectiveness for assessing rationalization, standardization, and interoperability (RSI) initiatives affecting the U.S. Army. The Army RSI Policy Office in the Office of the Deputy Chief of Staff for Plans and Operations (ODCSOPS), Headquarters, Department of the Army, needs such measures to assess the potential of RSI for contributing to the Army goals of increasing force effectiveness and conserving scarce resources and to develop recommendations to support RSI policy and resource-allocation decisions.

SCOPE

In this study, we develop measures of effectiveness for interoperability initiatives as they relate to U.S./NATO corps and army group "AirLand" battlefield operations in Central Europe; we also propose possible measures of effectiveness for rationalization and standardization. Specifically, focusing on battlefield interoperability, we (1) recommend ways to measure improvements in effectiveness that result from communications interoperability and common logistics support; (2) discuss ways to relate rationalization and standardization to battlefield interoperability and how their effectiveness can be assessed by the same or similar measures of effectiveness; and (3) recommend methods for applying the measures of effectiveness. The focus of the study and its relation to the decision process is illustrated in Figure 1-1. We do not analyze the effectiveness of specific RSI initiatives or propose solutions to specific RSI issues.

BACKGROUND

The U.S. Army is committed to supporting national objectives to achieve greater RSI of weapons systems and equipments with our principal allies, particularly within NATO. While the Army RSI emphasis is on activities in the

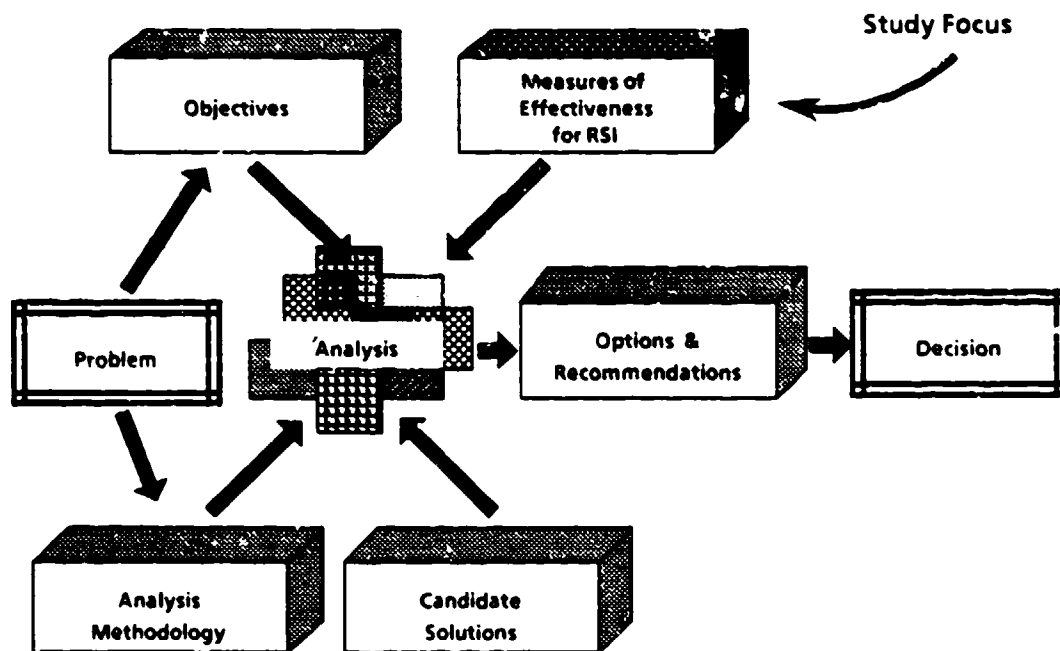


FIG. 1-1. RELATIONSHIP OF THIS STUDY TO RSI ANALYSIS STRUCTURE

NATO arena, RSI issues also arise in other alliances, in bilateral relations, and in America-Britain-Canada-Australia (ABCA) quadripartite programs.

As with other programs, the resources available for RSI activities are less than the known requirements, and RSI initiatives, therefore, must compete with other defense programs for limited funds. Since that is the case, the Army must be able to identify those RSI initiatives that will make the greatest contribution to battlefield success and resource conservation. To facilitate assessment of the potential contribution of RSI activities to Army goals of increasing force effectiveness and conserving scarce resources, the Army RSI Policy Office asked the Logistics Management Institute (LMI) to develop appropriate RSI measures of effectiveness.

ORGANIZATION

Chapter 2 presents a summary of our findings, conclusions, and recommendations; Chapter 3 discusses our recommended measures of effectiveness for interoperability in greater detail; Chapter 4 proposes measures of effectiveness for rationalization and standardization; and Chapter 5 discusses the application of the interoperability measures of effectiveness. Appendix A presents definitions and

discusses the interrelationships of rationalization, standardization, and interoperability as used in the study; Appendix B contains RSI issues and effectiveness criteria that influenced development of the measures of effectiveness; Appendix C contains the data collection instruments that were used; Appendix D identifies commands and agencies visited and individuals interviewed; Appendix E contains worksheets for developing battlefield effectiveness improvement indices.

CHAPTER 2

FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

FINDINGS

- RSI initiatives contribute to battlefield effectiveness in the same manner as other actions taken to overcome battlefield deficiencies or improve capabilities.
- The Army does not currently have any stated measures of effectiveness for RSI initiative evaluation.
- Most operational/tactical commanders and combat developers have similar interoperability concerns and criteria for assessing battlefield effectiveness.
- Communications with allied forces and the ability to use critical supplies are the principal interoperability concerns of commanders.
- Criteria for assessing interoperability initiatives include resource implications as well as measurement of improvements in functional area performance.
- Criteria for assessing the effectiveness of communications and logistics interoperability initiatives are similar except for mission-specific or functional area performance aspects.
- Criteria for assessing effectiveness under coalition warfare conditions also include capabilities for reconstitution or force regeneration.
- Army leadership is concerned that RSI initiatives not diminish the ability of U.S. forces to conduct independent operations.
- RSI initiatives have economic and political implications as well as an impact on battlefield effectiveness.
- The effects of RSI decisions on alliance strength, economic equity, and time-to-field systems are concerns of commanders and combat developers.
- RSI initiatives can result in changes in systems and personnel requirements through specialization of function, elimination of duplicate capabilities, and use of host nation and alliance assets.
- RSI initiatives can reduce system acquisition costs.

- RSI initiatives can provide access to needed technologies.
- Overcoming support shortfalls is a desired outcome of RSI initiatives.
- Improvements in effectiveness of resource use, functional area performance, and satisfaction of commanders' priorities are not of equal value.
- For definitional purposes, standardization is considered a rationalization action where the primary desired effect is interoperability.
- Criteria for assessing standardization initiatives include the general criteria for interoperability and technology gain and reduced acquisition time.
- Criteria for assessing rationalization initiatives include increasing alliance strength while maintaining capabilities for independent operations in addition to technology gain, reduced acquisition time, improved battlefield effectiveness, and resource conservation measures.
- None of the models, training exercises, or other evaluation tools examined in this study reflect coalition warfare logistics or communications conditions.

CONCLUSIONS

- Measures of effectiveness should facilitate the assessment of the merits of a wide range of solutions to RSI issues, challenges, and opportunities.
- Changes in battlefield effectiveness and the resource implications that result from RSI initiatives can be measured or estimated.
- RSI initiatives should be assessed in terms of operational, economic, and political impacts.
- Measures of effectiveness for interoperability should be applicable across mission or functional areas.
- The assessment methodology for interoperability initiatives should be able to weight differences in values among improvements in the various aspects of resource conservation and mission or functional area effectiveness.
- The effectiveness of standardization and rationalization initiatives should be assessed using interoperability measures of effectiveness together with standardization- and rationalization-specific measures of effectiveness that emphasize political and economic contributions.
- Current simulation and gaming procedures must be modified to ensure assessment under conditions of coalition warfare if RSI initiatives are to be evaluated fully.

- A full assessment of RSI initiatives must include consideration of mobilization, deployment, employment, and sustainment phases under coalition warfare conditions.

RECOMMENDATIONS

- For measures of effectiveness of interoperability initiatives, we recommend that analysts and decision makers use changes in:
 - ▶ Functional area performance
 - ▶ Personnel requirements
 - ▶ System costs
 - ▶ Supporting-to-supported ratio
 - ▶ Reconstitution capability
 - ▶ Satisfaction of the priorities of the commanders in chief (CINCs).
- For measures of effectiveness of rationalization and standardization initiatives, we recommend that analysts and decision makers use the interoperability measures of effectiveness together with changes in:
 - ▶ Technology gain
 - ▶ Acquisition time
 - ▶ Alliance strength
 - ▶ Economic equity in procurement
 - ▶ Capability to conduct independent operations.
- We also recommend the use of a battlefield effectiveness improvement index that reflects weighted and aggregated values of the measures of effectiveness to provide consistency in evaluation of initiatives.
- We further recommend that RSI initiatives be evaluated under conditions of coalition warfare scenarios that include mobilization, deployment, employment, and sustainment phases.

CHAPTER 3

MEASURES OF EFFECTIVENESS FOR COMMUNICATIONS AND LOGISTICS SUPPORT INTEROPERABILITY

INTRODUCTION

The inability to communicate and to share logistics resources with our allies are two of the most critical issues facing U.S. Army commanders in Europe. In helping to resolve these and other interoperability issues, the Army RSI Policy Office must be cognizant of the impact of RSI policy and resource allocation decisions on battlefield effectiveness and resource conservation. RSI initiatives should improve the performance of battlefield functions in coalition warfare or combined operations settings, ameliorate resource deficiencies in U.S. battlefield support capabilities, increase the efficiency of U.S. and alliance personnel and facilities, and resolve the critical interoperability issues as seen by the CINCs. The measures of effectiveness used to evaluate RSI initiatives should gauge improvements in force efficiency and effectiveness and provide consistency in comparing initiatives. This chapter identifies six measures of effectiveness encompassing improvements in functional area performance, resource use, and satisfaction of commanders' priorities for interoperability initiatives; defines comparable effectiveness measures among them; and then develops an RSI battlefield effectiveness improvement index (RSI-BEII) to facilitate their use in comparing interoperability initiatives.

THE MEASURES OF EFFECTIVENESS

Interoperability initiatives must increase the ability of forces and systems to provide and accept services and to operate effectively together on the battlefield. Interoperability measures of effectiveness must assess the effects of an initiative on several attributes encompassing battlefield operations and interfaces and resource use. The measures developed in this study focus on interoperable communications and common logistics support and the corresponding resource conservation, and they define criteria for assessing the effectiveness of RSI initiatives in those areas. They can be used to evaluate initiatives involving other functional areas provided that

improvements in the functional area performance for those areas are defined. The six proposed attributes to be measured are as follows:

- Functional area performance
- Personnel requirements
- Systems costs
- Supporting-to-supported ratio
- Reconstitution capability
- Satisfaction of CINCs' priorities.

Functional Area Performance Measure

The functional area performance measure of effectiveness is defined as the change in satisfaction of requirements within a specific functional area, mission area, or battlefield operating system when the RSI initiative is implemented.

Performance in functional areas in combined operations can be enhanced by interoperable systems that use compatible communications and common logistics support. If systems are interoperable, the time required to perform critical battlefield functions in a coalition warfare environment can be reduced, thereby increasing the overall effectiveness and efficiency of the force and reducing delays in planning, coordinating, or executing operations. Interoperable systems can also eliminate time-intensive, field-expedient solutions.

The measure of change in functional area performance brought about by an RSI initiative is dependent on the functional area that is being assessed and the evaluation conditions. We discuss methodologies for evaluating functional area performance for communications and logistics initiatives in this report. The variables that we recommend be measured in the communications and logistics support cases are indicators of performance in those areas. Other battle-outcome variables such as forward-line-of-own-troops (FLOT) movement, loss-exchange ratios, or fractional-exchange ratios may be used if desired or appropriate for evaluating other functional areas such as fire support, command and control, or air defense artillery.

Personnel Requirements Measure

The personnel requirements measure of effectiveness is defined as the change in total requirements for personnel as a consequence of the RSI initiative.

Personnel requirements include those for sustaining base personnel as well as for forward-deployed and contingency force personnel. The measure should include estimated casualties that would be averted as a consequence of the initiative.

The personnel requirements measure of effectiveness accounts for the impact of the initiative on reducing unfilled personnel requirements and on increasing the availability of personnel either to fill unsatisfied functional area requirements or to improve other functional area performance. It also provides for the assessment of possible increases in personnel requirements arising from the initiative.

Improvements in battlefield effectiveness without increases in personnel requirements are desirable and attainable outcomes of RSI initiatives. For example, specialization and consolidation actions have the potential for increasing effectiveness without increasing personnel requirements. They may in fact increase the availability of personnel for use in satisfying other unfilled requirements by eliminating duplicate functions and facilities, by transferring functions to the host nation or another alliance member, or by using common alliance facilities such as communications networks. Standardization agreements on systems may result in improved performance with minimum or no increase in operator and support personnel requirements. Interoperable initiatives may result in systems that can reduce the requirements for manual interfaces, liaison staffs, and additional command-and-control personnel necessitated by noninteroperable systems.

Available support personnel can provide more effective support, and unsatisfied requirements for personnel may be reduced as a result of initiatives that eliminate duplicate systems. Additionally, personnel requirements may change as a result of consolidation of support activities, internationalization of support functions, or introduction of standardized systems having reduced U.S. support requirements. Standardized systems and interoperable procedures that result in consolidation of alliance training facilities may also produce changes in training personnel requirements and effectiveness.

The changes in personnel requirements should be estimated, projected, or derived from analysis of the proposed initiatives and stated in terms of U.S. or alliance needs.

Systems Costs Measure

The systems costs measure of effectiveness is defined as the change in total dollar costs of systems affected by the RSI initiative. Those costs include all non-personnel-related life-cycle costs that would accrue to the United States.

The elimination of duplicate systems, the use of other nation or alliance facilities, and the specialization of roles and functions can reduce the number of systems required. Acquisition of nondevelopmental items, sharing of R&D costs, and consolidation of procurement actions can reduce system costs.

As an alternative to systems costs stated in dollars, the product of a weighted value of the systems under consideration in an RSI initiative and the number of systems saved through the initiative may be used to arrive at a systems costs measure of effectiveness. We do not analyze such systems weights in this report.

Supporting-to-Supported Ratio Measure

The supporting-to-supported ratio measure of effectiveness is defined as the change in the ratio of the number of U.S. personnel required in the supporting force to the number of U.S. personnel in the supported force.

RSI actions can improve force effectiveness and eliminate unsatisfied support requirements while holding supporting force personnel requirements constant or even reducing them. RSI actions can affect effective combat power by increasing or decreasing the availability of personnel to perform combat roles. RSI initiatives that can result in changes in the supporting-to-supported ratio include acquisition of systems that change the number of support personnel or change the structure of support organizations, specialization of indigenous forces in support functions, use of existing alliance support capabilities, use of alliance industrial base for higher level maintenance and support functions, and internationalization of support structures.

Requirements for supporting force personnel can be derived from analysis of the initiative using current or developmental models or staff estimates.

Reconstitution Capability Measure

The reconstitution capability measure of effectiveness is defined as the change in the average number of battalion-size organizations that can be regenerated from residual forces.

Forces are normally withdrawn from combat when their strength in manpower or critical systems drops below a specified level. Such forces are no longer available to the commander until they have been regenerated from command resources or through replacement of shortages from external sources. Reconstitution of an allied force is dependent on the degree of interoperability of the various systems within the force, the ability of personnel to operate those systems, and the ability of the combat service support systems to sustain the combined force. The availability of interoperable systems and procedures and compatible doctrine and tactics should allow faster regeneration of forces with experienced personnel and should enhance the overall effectiveness of the force.

In applying this measure of effectiveness to the initiative, the number of battalions should be stated as the average number available during the employment and sustainment phases of operations. As an alternative, the measure of effectiveness could be stated as the change in the sum of the products of the weighted value of the type of battalion regenerated and the number of battalions by type. We do not analyze such weights for the various types of battalions in this report.

Satisfaction of CINCs' Priorities Measure

The degree of satisfaction of the CINCs' priorities for battlefield development and, in particular, their priorities for RSI initiatives is the final measure in the recommended interoperability measures of effectiveness. Currently, no mechanism exists for identifying the CINCs' priorities among various RSI initiatives. Such a process should be developed to ensure that their priorities are included in the RSI policy formulation process. We recommend that the measure of effectiveness be the CINCs' stated value of the initiative or, as an alternative, the product of the weighted value of the requirement and the degree to which the initiative satisfies that requirement.

COMPARABLE EFFECTIVENESS IMPROVEMENT VALUES

To compare and aggregate the six measures of effectiveness into a single index, we propose use of effectiveness improvement values (Exx's) that transform the change measured in each measure of effectiveness into a degree of change compared to a base case. Used with the measures of effectiveness weights, defined later in this chapter, these values facilitate the use of a battlefield effectiveness improvement index (BEII) to make comparisons among initiatives. This section defines the comparable effectiveness improvement value for each measure of effectiveness in the same mathematical form.

Functional Area Effectiveness Improvement

The functional area effectiveness improvement value, Efa, varies depending on the functional area under evaluation. We discuss methodologies for assessing the communications and logistics functional areas later in the chapter.

Personnel Requirements Effectiveness Improvement

The personnel requirements effectiveness improvement value, Epr, is the ratio of change in personnel requirements for a function resulting from the initiative and the requirements for personnel without the RSI initiative, or program.

$$E_{pr} = \frac{\text{Change in personnel requirements}}{\text{Personnel requirements in base case}} \quad [\text{Eq. 3-1}]$$

Decreases in personnel requirements are stated as positive ratios and increases are stated as negative ones. To compare personnel requirements effectiveness for several initiatives, the number of personnel in the base case must be the same for all of them. The base case value may be stated in terms of a desired personnel requirement level or in terms of current requirements.

Systems Cost-Effectiveness Improvement

The systems cost-effectiveness improvement value, Esc, is the ratio of the change in systems costs to systems costs in the base case.

$$E_{sc} = \frac{\text{Change in systems cost}}{\text{Base case systems cost}} \quad [\text{Eq. 3-2}]$$

Cost decreases are stated as positive ratios, and increases are stated as negative ones. Again, the base case cost should be constant for all alternatives being evaluated. It may be stated in terms of desired costs or in terms of current systems costs.

Supporting-to-Supported Ratio Effectiveness Improvement

The supporting-to-supported ratio effectiveness improvement value, E_{sr} , is a measure of force structure efficiency. We propose using the ratio of the change in percentage of supporting force personnel in the total force to the percentage of supporting force personnel in the total force in the base case. Decreases in the percentage of supporting force personnel with respect to the total force are stated as positive ratios, and increases are stated as negative ones.

$$E_{sr} = \frac{\text{Change in percentage of supporting force personnel in total force}}{\text{Percentage of supporting force personnel in total force in base case}} \quad [\text{Eq. 3-3}]$$

Reconstitution Capability Effectiveness Improvement

The reconstitution capability effectiveness improvement value, E_{rc} , is the ratio of the change in the average number of reconstituted battalions to the number of battalions in the base case force. Increases in the number of reconstituted battalions are stated as positive ratios, and decreases are stated as negative ones.

$$E_{rc} = \frac{\text{Change in average number of reconstituted battalions}}{\text{Number of battalions in base case}} \quad [\text{Eq. 3-4}]$$

The desired number of reconstituted battalions may be used as an alternative to the number of battalions in the base case when calculating the ratio, provided that the number is constant across all alternatives.

Satisfaction of CINCs' Priorities Effectiveness Improvement

The satisfaction of the CINCs' priorities effectiveness improvement value, E_{cp} , is not stated as a ratio but as the prioritized weighting of the initiative as developed from inputs from the various CINCs.

$$E_{cp} = \text{CINCs' weighted value of the RSI initiative} \quad [\text{Eq. 3-5a}]$$

As an alternative, if the CINCs' RSI requirements are stated in quantifiable terms, such as interoperability of all combat net radios within each army group or standardization of a class of consumables, then the degree to which the CINCs' requirements are satisfied can be considered. In this case, the proposed value is:

$$Ecp(alt) = \frac{\text{Degree of satisfaction of CINCs' requirements}}{\text{Weight of the initiative}} \times [\text{Eq. 3-5b}]$$

WEIGHTS OF RSI MEASURES OF EFFECTIVENESS

The proposed weights for the measures of effectiveness for communications initiatives are shown in Table 3-1, and those for logistics initiatives are shown in Table 3-2. The weighting of the components was developed using a pairwise comparison technique, which combines knowledge derived from military experience with logical thinking to create a prioritized hierarchy of values. The values are proportions of 1,000. The instrument used for developing the weights is presented in Appendix C. If the proposed measures of effectiveness are accepted and the RSI-BEII methodology is implemented, the weights should be redeveloped with a larger sample than was used in this study.

TABLE 3-1
WEIGHTS FOR COMMUNICATIONS INITIATIVES
MEASURES OF EFFECTIVENESS

Measure of effectiveness	Weights ^a
Communications performance	211
Personnel requirements	156
Systems costs	065
Supporting-to-supported ratio	118
Reconstitution capability	212
CINCs' priorities satisfaction	244

^a Proportions of 1,000

TABLE 3-2
WEIGHTS FOR LOGISTICS INITIATIVES MEASURES OF EFFECTIVENESS

Measure of effectiveness	Weights ^a
Logistics performance	158
Personnel requirements	168
System costs	080
Supporting-to-supported ratio	149
Reconstitution capability	217
CINCS' priorities satisfaction	231

^a Proportions of 1,000.

THE IMPROVEMENT INDEX

We propose use of a BEII to facilitate comparison among initiatives. The proposed RSI-BEII is

$$RSI - BEII = (Wfa \times Efa) + (Wpr \times Epr) + (Wsc \times Esc) + (Wsr \times Esr) + (Wrc \times Erc) + (Wcp \times Ecp) \quad [Eq. 3-6]$$

where

- Wfa = the weight of improvement in functional area performance
- Efa = the comparable functional area effectiveness improvement value
- Wpr = the weight of improvement in personnel requirements
- Epr = the comparable functional effectiveness improvement value
- Wsc = the weight of improvement in systems costs
- Esc = the comparable systems cost-effectiveness improvement value
- Wsr = the weight of improvement in the supporting force to total force ratio
- Esr = the comparable supporting-to-supported ratio effectiveness improvement value
- Wrc = the weight of improvement in reconstitution capability

- Erc = the comparable reconstitution capability effectiveness improvement value
- Wcp = the weight of the CINCs' RSI priorities, and
- Ecp = the degree of satisfaction of the CINCs' RSI priorities effectiveness improvement value.

Relationships among the attribute measures, the comparable effectiveness improvement values, and the BEII are shown in Figure 3-1.

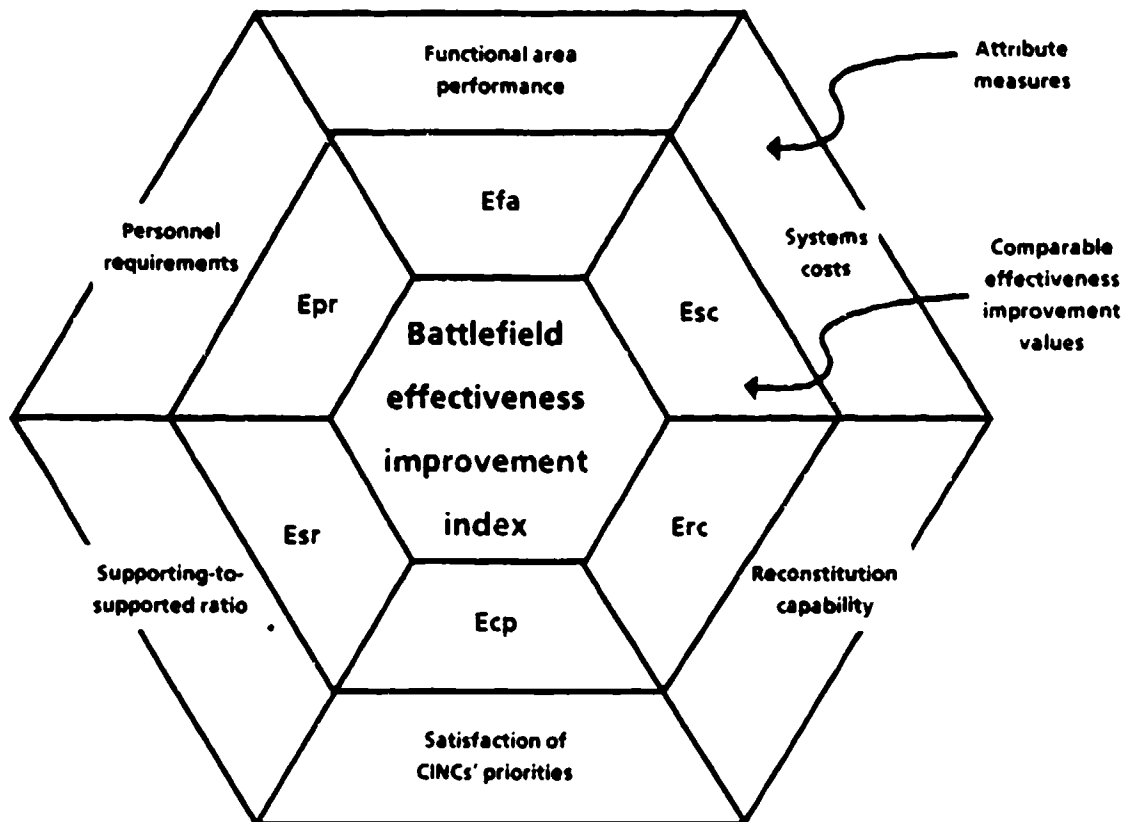


FIG. 3-1. RELATIONSHIPS AMONG ATTRIBUTE MEASURES, COMPARABLE EFFECTIVENESS IMPROVEMENT VALUES, AND BATTLEFIELD EFFECTIVENESS IMPROVEMENT INDEX

COMMUNICATIONS FUNCTIONAL AREA PERFORMANCE

Measures of effectiveness for communications initiatives must be designed to assess changes in communications functional area performance as well as changes in the other five attribute measures. Changes in the latter five are inherent in the communications initiative and can be calculated or estimated directly from the character of the initiative. The change in functional area performance, however, requires further analysis. We recommend the degree to which critical

communications requirements are satisfied, weighted by supported mission area and echelon, be used as the basic communications functional area performance measure.

Critical communications requirements can be stated in terms of capacity or any other measurable performance characteristic. However, for purposes of evaluating battlefield effectiveness, the time needed to perform communications-dependent events is an appropriate substitute for other performance characteristics. This measure permits an assessment of operational events in proximity to the communications activity without uncontrolled variables intervening between the communications activity and the assessed event.

The value of satisfaction of stated requirements for a particular initiative is a function of the mission areas supported and the echelons at which the interoperable communications are provided. The potential scope of analysis is shown in Figure 3-2. It includes the echelons, the mission areas, and the required communications activities.

To reduce the scope of analysis to manageable proportions, we recommend that only the most critical activity be used for each mission area and echelon. Within the battalion, for example, the most critical fire support (FS) system activity is an immediate call for fires, while the most time-sensitive communication requirement for the air defense (AD) system is the warning of the presence of hostile aircraft. Figure 3-3 portrays the essential scope of analysis for communications.

The measure of effectiveness for communication is then defined as

$$D = \sum_i \sum_j W_{ei} W_{mj} \times D_{ij} \quad [\text{Eq. 3-7}]$$

where

- D = aggregate degree of satisfaction of the requirement for the most critical activity
- W_{ei} = the weight for the i^{th} echelon
- W_{mj} = the weight for the j^{th} mission area, and
- D_{ij} = degree of satisfaction of the requirement for the most critical activity for the i^{th} echelon and the j^{th} mission area.

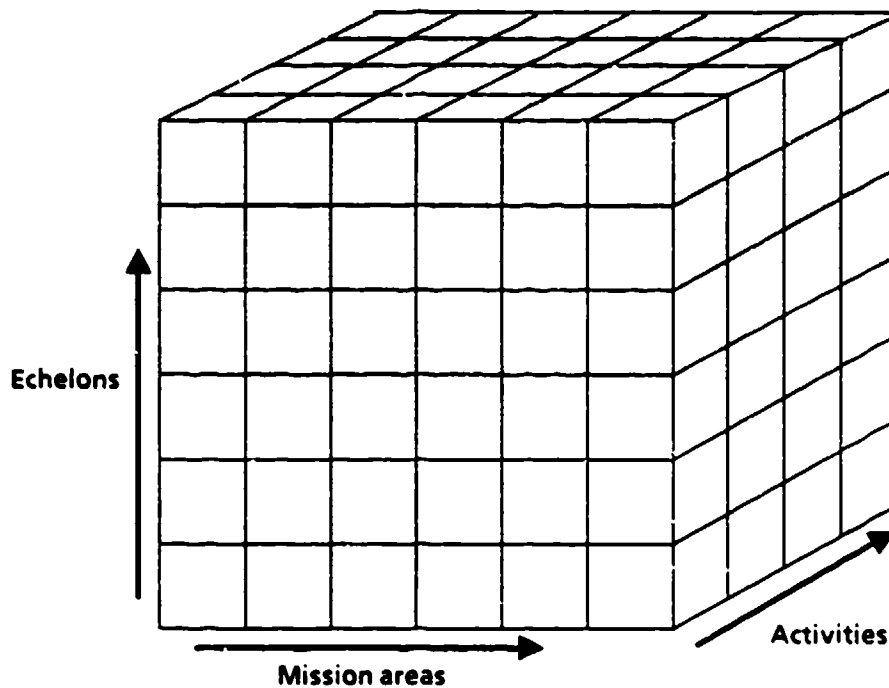


FIG. 3-2. POTENTIAL SCOPE OF ANALYSIS FOR COMMUNICATIONS

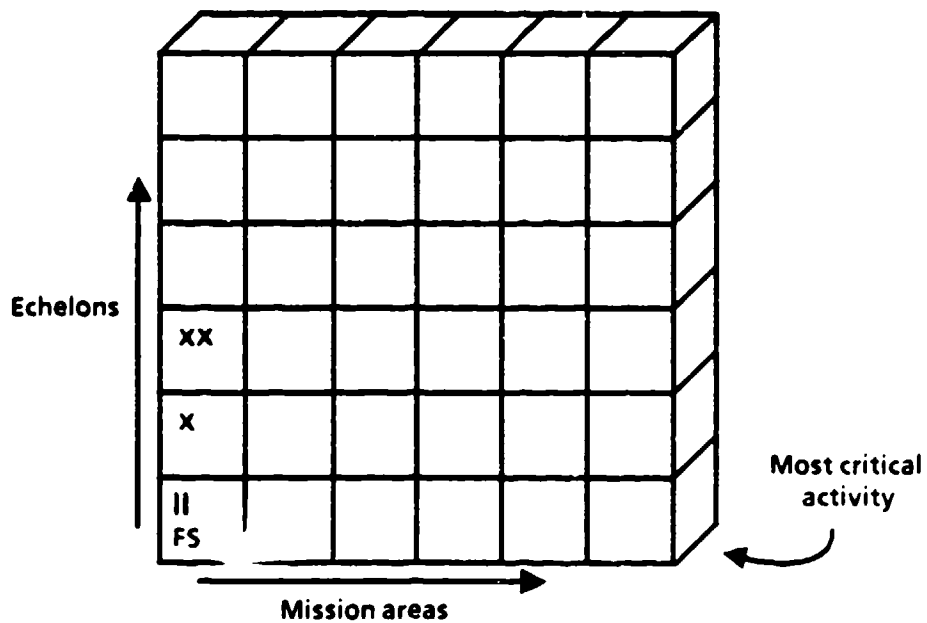


FIG. 3-3. ESSENTIAL SCOPE OF ANALYSIS FOR COMMUNICATIONS

The degree of satisfaction of a requirement may generally be conceived as a ratio of the performance achieved, P, and the required performance, R. If smaller values of P are indicative of improvement (e.g., if P is the time to transmit a message), then the ratio would be $R/P \leq 1$. If greater values of P are indicative of improvement (e.g., if P is the number of messages transmitted in a given time), then the ratio would be $P/R \leq 1$.

Possible values for the degree of satisfaction of battalion fire support communications requirements derived from this methodology are portrayed in Figure 3-4. A similar relationship exists for each echelon. This function may not

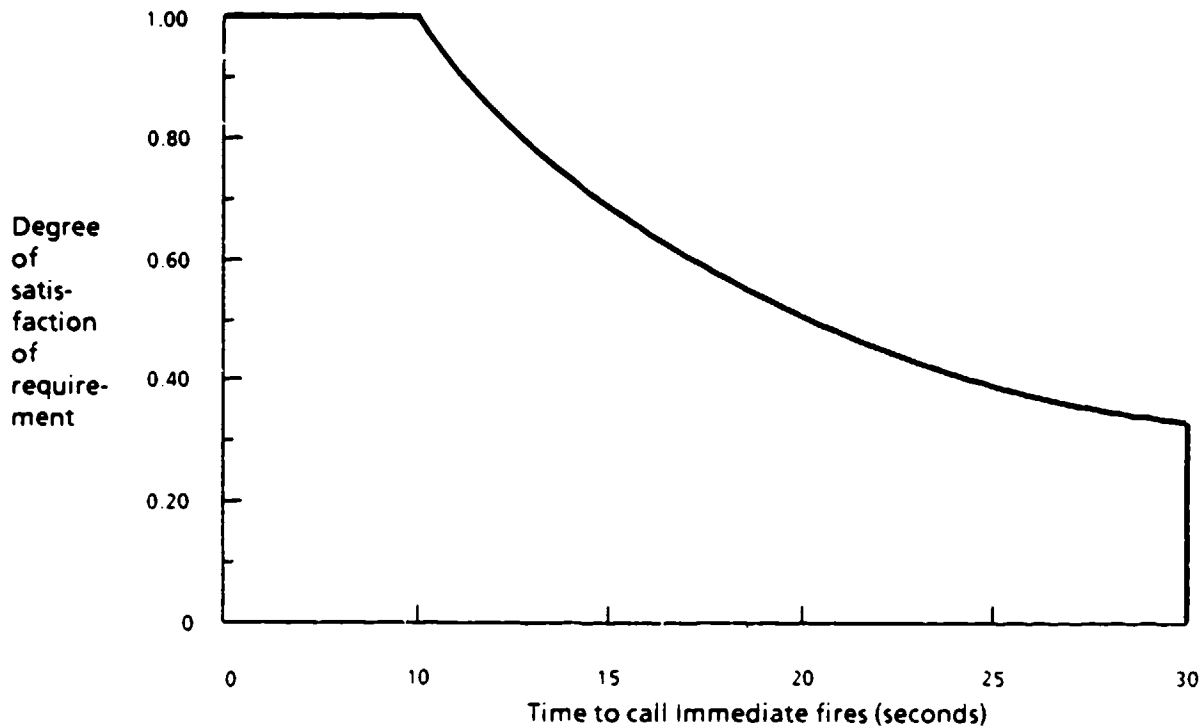


FIG. 3-4. VALUE OF TIME TO PERFORM A CRITICAL EVENT

capture the exact relationship between time to perform the function and its value. However, for purposes of comparison, if we use minimum acceptable and desired values for each echelon to define the range of the function for each echelon, the methodology should be adequate to distinguish differences in effectiveness among alternatives. Time requirements (R) should be extracted from the communications requirements database or a similar database. Echelon and mission area values can be extracted from the Army Battlefield Interface Concept (ABIC), prepared by the U.S. Army Combined Arms Combat Development Activity, Fort Leavenworth.

Kansas, or can be developed separately for each RSI alternative analysis. P values can be extracted from exercise, simulation, experimentation, engineering specification, or experiential data.

Communications Comparable Effectiveness Improvement Value – Efa(c)

The ratio of the improvement in communications from the base case as a result of the initiative under evaluation and the communications performance of the base case is the comparable effectiveness improvement value for use in formulating the RSI-BEII(c).

$$Efa(c) = \frac{\text{Improvement in communications performance}}{\text{Base case communications performance}} \quad [\text{Eq. 3-8}]$$

Communications Effectiveness Improvement Index – RSI-BEII(c)

The BEII for RSI communications initiatives is the sum of the products of the weights for communications performance, personnel requirements, systems costs, supporting-to-supported ratio, reconstitution capability, and satisfaction of CINCs' priorities and their respective comparable effectiveness improvement values:

$$RSI - BEII(c) = [Wfa \times Efa(c)] + (Wpr \times Epr) + (Wsc \times Esc) + \\ (Wsr \times Esr) + (Wrc \times Erc) + (Wcp \times Ecp) \quad [\text{Eq. 3-9}]$$

where W, E, fa, pr, sc, sr, rc, and cp are as defined in Equation 3-6 and Efa(c) is as defined in Equation 3-8. A worksheet for the development of a communications RSI-BEII is contained in Appendix E.

LOGISTICS FUNCTIONAL AREA PERFORMANCE

The evaluation methodology we recommend for logistics initiatives is the same as that proposed for the communications initiatives except for the assessment of functional area performance. Measures for logistics effectiveness should address the logistics system as an entity; however, they should also provide for assessment in specific logistics elements: supply, services, maintenance, medical, and transportation. In the case of initiatives that affect the entire logistics system, we recommend that the average readiness condition of the supported force in terms of personnel and major systems be considered the basic measure. In the assessment of

initiatives affecting specific elements of the logistics functional area, we recommend that separate measures be used to address the satisfaction of requirements for each element. The value of logistics RSI initiatives must be assessed for mobilization, deployment, employment, and sustaining phases of plans if their complete benefits are to be measured. This study did not develop weights for echelons or other attributes of logistics measures of effectiveness. In the absence of other direction, the echelon weights contained in the Army Battlefield Interface Concept (ABIC) prepared by the United States Army Combined Arms Combat Development Activity, Fort Leavenworth, Kansas, may be used and all other factors considered as having equal weight.

We define the logistics system functional area performance measure as the average readiness condition of the supported force in terms of personnel and major systems.

Logistics Comparable Effectiveness Improvement Value - Efa(l)

The readiness condition of the supported force may be stated in any of several forms - commanders' daily summaries during exercises, simulation results in the form of daily unit status, or current Army unit readiness condition reporting requirements. The value to a commander of the degree of readiness resulting from a particular initiative can be a function of the element, functional area, criticality of the systems, or other factors. These values tend to change with battlefield conditions. For that reason, we have not developed degrees of importance for echelons, functional areas, skills, or systems specifically for logistics initiative evaluation.

The comparable logistics effectiveness improvement value, Efa(l), is defined as follows:

$$EFA(l) = \left[Personnel\ weight \times \frac{Increase\ in\ personnel\ available}{Personnel\ available\ in\ base\ case} \right] + \left[Systems\ weight \times \frac{Increase\ in\ major\ systems\ available}{Major\ systems\ available\ in\ base\ case} \right] \quad [Eq. 3-10]$$

Where weights for personnel and systems are not defined, we recommend that they each be assigned a value of 500.

Logistics Effectiveness Improvement Index - RSI-BEII(I)

The methodology for calculating a logistics RSI-BEII is the same as that for a communications RSI-BEII.

The recommended logistics system BEII is as follows:

$$RSI - BEII(I) = [Wfa \times Efa(I)] + (Wpr \times Epr) + (Wsc \times Esc) + (Wsr \times Esr) + (Wrc \times Erc) + (Wcp \times Ecp) \quad [Eq. 3-11]$$

where $Efa(I)$ is as defined in Equation 3-10 and all other elements are as defined in Equation 3-6. A worksheet for the development of a logistics RSI-BEII is included in Appendix E.

Supply Performance

Supply system performance is defined as the degree to which supply requirements are satisfied weighted by echelon, e, and class of supply, c. That is,

$$Supply\ performance = \sum_i \sum_j Wei Wcj \times Pij / Rsuppij \quad [Eq. 3-12]$$

where

- Wei = the weight for the i th echelon
- Wcj = the weight for the j th class of supply
- Pij = the supply performance for the i th echelon and the j th class of supply as a result of the initiative
- $Rsuppij$ = the supply requirement for the i th echelon and the j th class of supply, and
- $P/R \leq 1.$

Figure 3-5 portrays the scope of supply effectiveness analysis. We recommend that the echelon and supply class weights be obtained from the Army Logistics Center when required.

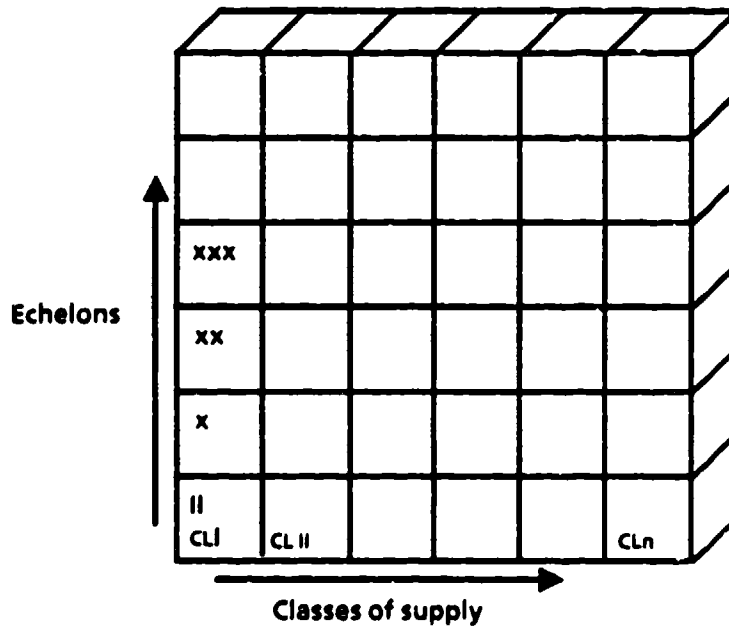


FIG. 3-5. SCOPE OF SUPPLY EFFECTIVENESS ANALYSIS

Comparable Supply Effectiveness Improvement Value – $E_{fa}(supp)$

The $E_{fa}(supp)$ is the ratio of the improvement in supply system capabilities as a result of the RSI initiative compared to the supply system capabilities in the base case.

$$E_{fa}(supp) = \frac{\text{Increase in supply capability}}{\text{Base case supply capability}} \quad [\text{Eq. 3-13}]$$

Supply Effectiveness Improvement Index – $RSI-BEII_{supp}$

The proposed supply $RSI-BEII$ is

$$RSI-BEII_{supp} = [W_{fa} \times E_{fa}(supp)] + (W_{pr} \times E_{pr}) + (W_{sc} \times E_{sc}) + (W_{sr} \times E_{sr}) + (W_{rc} \times E_{rc}) + (W_{cp} \times E_{cp}) \quad [\text{Eq. 3-14}]$$

where $E_{fa}(supp)$ is as defined in Equation 3-13 and all other elements are as defined in Equation 3-6.

Services Performance

Services performance is defined as the degree of satisfaction of services weighted by echelon and type service. That is,

$$\text{Services performance} = \sum_i \sum_j W_{ei} W_{serj} \times P_{ij} / R_{serj} \quad [\text{Eq. 3-15}]$$

where

- W_{ei} = the weight for the i^{th} echelon
- W_{serj} = the weight for the j^{th} service
- P_{ij} = the service performance of the i^{th} echelon and the j^{th} type of service as a result of the initiative
- R = the service requirement, and
- $P/R \leq 1$.

Weights for echelons and services have not been developed for this study. We recommend that they be developed for each analysis as required.

Comparable Services Effectiveness Improvement Value - $E_{fa}(\text{ser})$

The comparable effectiveness improvement value for services initiatives is the ratio of the improvement in the satisfaction of requirements as a result of the RSI initiative to the satisfaction of requirements in the base case.

$$E_{fa}(\text{ser}) = \frac{\text{Improvement in services performance}}{\text{Base case services performance}} \quad [\text{Eq. 3-16}]$$

Services Effectiveness Improvement Index - $RSI-BEII_{ser}$

The proposed services BEII is

$$RSI-BEII_{ser} = [W_{fa} \times E_{fa}(\text{ser})] + (W_{pr} \times E_{pr}) + (W_{sc} \times E_{sc}) + (W_{sr} \times E_{sr}) + (W_{rc} \times E_{rc}) + (W_{cp} \times E_{cp}) \quad [\text{Eq. 3-17}]$$

where $E_{fa}(\text{ser})$ is as defined in Equation 3-16 and all other elements are as defined in Equation 3-6.

Maintenance Performance

Maintenance performance is defined as the sum of the degrees of satisfaction of system recovery, evacuation, and repair requirements weighted by echelon, system,

and function. That is,

$$\text{Maintenance performance} = \sum_i \sum_j W_{ei} W_{sj} [(W_a \times P_{aij}/R_{aij}) + (W_b \times P_{bij}/R_{bij}) + (W_c \times P_{cij}/R_{cij})] \quad [\text{Eq. 3-18}]$$

where

- W_{ei} = the weight for the i^{th} echelon
- W_{sj} = the weight for the j^{th} system
- W_a = the weight for recovery
- W_b = the weight for evacuation
- W_c = the weight for repair
- $P_{a, b, \text{ or } cij}$ = the performance of the i^{th} echelon and the j^{th} system as a result of the initiative
- $R_{a, b, \text{ or } cij}$ = the requirement of the i^{th} echelon and the j^{th} system, and
- $P/R \leq 1$.

Weights for echelon, system, and function (recovery, evacuation, and repair) have not been developed in this study. They should be obtained from the Army Logistics Center or other agency to support specific analysis, or they should be considered as being equal.

Maintenance Comparable Effectiveness Value – $E_{fa}(mt)$

$E_{fa}(mt)$ is the ratio of the improvement in effectiveness as a result of the RSI initiative to maintenance effectiveness in the base case.

$$E_{fa}(mt) = \frac{\text{Improvement in maintenance performance}}{\text{Base case maintenance performance}} \quad [\text{Eq. 3-19}]$$

Maintenance Effectiveness Improvement Index – $RSI-BEII_{mt}$

The proposed maintenance BEII is

$$RSI-BEII_{mt} = [W_{fa} \times E_{fa}(mt)] + (W_{pr} \times E_{pr}) + (W_{sc} \times E_{sc}) + (W_{sr} \times E_{sr}) + (W_{re} \times E_{re}) + (W_{cp} \times E_{cp}) \quad [\text{Eq. 3-20}]$$

where $E_{fa}(mt)$ is defined in Equation 3-19 and all other elements are as defined in Equation 3-6.

Medical Performance

Medical performance is defined as the degree of satisfaction of medical requirements weighted by echelon and facility. That is,

$$\text{Medical effectiveness} = \sum_i \sum_j W_{ei} W_{fj} \times P_{ij} / R_{ij} \quad [\text{Eq. 3-21}]$$

where

W_{ei} = the weight for the i^{th} echelon

W_{fj} = the weight for the j^{th} facility

P_{ij} = the performance of the i^{th} echelon and the j^{th} facility as a result of the initiative

R_{ij} = the requirement of the i^{th} echelon and the j^{th} facility, and

$P/R \leq 1$.

Weights for echelons and facilities should be developed to support each analysis.

Medical Comparable Effectiveness Value - $E_{fa}(\text{med})$

$E_{fa}(\text{med})$ is the ratio of the improvement in requirements satisfaction as a result of the RSI initiative to the satisfaction of medical requirements in the base case.

$$E_{fa}(\text{med}) = \frac{\text{Improvement in medical performance}}{\text{Base case medical performance}} \quad [\text{Eq. 3-22}]$$

Medical Effectiveness Improvement Index - RSI-BEII_{med}

The proposed medical BEII is

$$\begin{aligned} \text{RSI-BEII}_{\text{med}} = & \{W_{fa} \times E_{fa}(\text{med})\} + (W_{pr} \times E_{pr}) + (W_{sc} \times E_{sc}) + \\ & (W_{sr} \times E_{sr}) + (W_{rc} \times E_{rc}) + (W_{cp} \times E_{cp}) \end{aligned} \quad [\text{Eq. 3-23}]$$

where $E_{fa}(\text{med})$ is defined in Equation 3-22 and all other elements are as defined in Equation 3-6.

Transportation Performance

Transportation performance is defined as the degree of satisfaction of transportation requirements weighted by echelon and mode. That is,

$$\text{Transportation effectiveness} = \sum_i \sum_j W_{ei} W_{tmj} \times P_{ij} / R_{ij} \quad [\text{Eq. 3-25}]$$

where

W_{ei} = the weight for the i^{th} echelon

W_{tmj} = the weight for the j^{th} mode of transport

P_{ij} = the performance of the i^{th} echelon and the j^{th} mode as a result of the initiative

R_{ij} = the requirement of the i^{th} echelon and the j^{th} mode, and

$P/R \leq 1$.

Weights were not developed for transportation modes or echelons. When required, they should be obtained from the Army Logistics Center or other appropriate source.

Transportation Comparable Effectiveness Value - $E_{fa}(tr)$

The recommended $E_{fa}(tr)$ is the ratio between the improvement resulting from the RSI initiative and transportation effectiveness in the base case.

$$E_{fa}(tr) = \frac{\text{Improvement in transportation performance}}{\text{Base case transportation performance}} \quad [\text{Eq. 3-26}]$$

Transportation Effectiveness Improvement Index - $RSI-BEII_{tr}$

The proposed transportation BEII is

$$RSI-BEII_{tr} = [W_{fa} \times E_{fa}(tr)] + (W_{pr} \times E_{pr}) + (W_{sc} \times E_{sc}) + (W_{sr} \times E_{sr}) + (W_{rc} \times E_{rc}) + (W_{cp} \times E_{cp}) \quad [\text{Eq. 3-27}]$$

where $E_{fa}(tr)$ is defined in Equation 3-25 and all other elements are as defined in Equation 3-6.

SUMMARY OF METHODOLOGY

The measures of effectiveness are the criteria for assessing the contribution of interoperability initiatives to battlefield effectiveness and resource conservation. They provide a means for stating the benefits of the initiatives in commonly understood terms. The comparable effectiveness measures (Exx) provide a means for stating the changes in the various measured attributes in the same mathematical form. The weights of the measures of effectiveness reflect the relative worth of the changes in the various measured attributes. The RSI-BEII uses the comparable effectiveness measures and the weights of the measures of effectiveness to provide an index that can be used to compare RSI initiatives. To derive an RSI-BEII, we must first measure attribute performances and then convert those measures into comparable effectiveness measures; the comparable effectiveness measures then are multiplied by the weights of the respective measures of effectiveness and the resulting products are summed to create the RSI-BEII value for the initiative under consideration. We may then use the RSI-BEIIs to compare initiatives. A worksheet for the development of an RSI-BEII general case is included in Appendix E.

CHAPTER 4

MEASURES OF EFFECTIVENESS FOR RATIONALIZATION AND STANDARDIZATION

INTRODUCTION

The measures of effectiveness we recommend for assessing rationalization and standardization initiatives include those developed for interoperability initiatives together with additional measures appropriate for either rationalization or standardization initiatives. The assessment of standardization initiatives should consider technology gain and acquisition time, while rationalization initiatives should also consider such criteria as alliance strength, economic equity, and the retained capability for independent operations. Standardization measures of effectiveness are less quantifiable in nature than the interoperability criteria, and rationalization criteria are almost solely qualitative since they relate principally to perceptions of the initiative's effects. The rationalization and standardization measures should therefore be used in the RSI initiative decision process as qualitative criteria with the recommended interoperability measures of effectiveness. In this chapter, we discuss standardization measures first and then treat rationalization measures.

MEASURES OF EFFECTIVENESS FOR STANDARDIZATION INITIATIVES

Standardization initiatives should be directed towards developing concepts, doctrine, and designs that will result in compatible, interoperable, interchangeable, or common systems. Because interoperability is one of the desired products of standardization initiatives and is considered to be a degree of standardization, the measures of effectiveness for interoperability are applicable to standardization-related initiatives. In addition to the interoperability criteria defined in Chapter 3, the technological gain to the United States and the effects of the standardization action on systems acquisition time are standardization criteria.

Technology Gain

The recommended measure for technology gain is a U.S. intelligence and industrial community estimate of the initiative's impact on the U.S. technology base. Standardization of systems incorporating technological advances achieved by allies of the United States, in particular Western Europe and Japan, offers opportunities for introducing those technologies into the United States. The needs of the industrial base and the potential U.S. Army uses of advanced technologies should be an element in determining the value of a standardization initiative.

U.S. economic and security interests require the protection of critical technology. Assessment of standardization initiatives should also include an estimate of the impact on these interests of the transfer or compromise of the technology.

Acquisition Time

The recommended measure for acquisition time is the change in the time required to introduce the system or technology into U.S. forces. Specifically, we recommend using the estimated change in system initial operational capability (IOC) attributable to the initiative.

Standardization can be achieved by adopting alliance-developed standards, adhering to existing international standards, or accepting standards already in use by one or more alliance members. Such actions permit the cooperative development or the acquisition of existing systems by alliance members. The acquisition from allies of nondevelopmental items that meet agreed standards and satisfy U.S. Army requirements can shorten the acquisition process and result in earlier deployment of required capabilities. The development of alliance standards or systems to multi-nationally accepted standards may delay the deployment of desired capabilities. Possible delays in system IOC or in the introduction of advanced concepts or doctrine should be estimated and considered when evaluating standardization initiatives.

MEASURES OF EFFECTIVENESS FOR RATIONALIZATION INITIATIVES

Rationalization initiatives include actions directed towards consolidation, reassignment of priorities, standardization, and specialization to increase the efficiency of forces. The recommended measures of effectiveness for rationalization initiatives should therefore include an assessment of the resulting change in force

efficiency. The measures should also address the effects of the initiative on alliance strength, equity of procurement distribution among alliance members, and U.S. force's ability to perform independent operations.

Force Efficiency

The criterion for assessing force efficiency is the size of the force required to perform an assigned mission at a specified degree of effectiveness. This criterion is included to some degree in the interoperability-related measures of effectiveness: functional area performance, personnel requirements, system costs, supporting-to-supported ratio, and reconstitution capability.

Alliance Strength

The assessment of the effects of a rationalization initiative on alliance strength is qualitative. It should address the expected changes in force cohesion, political and economic support for the alliance, and the threat perception of the alliance resulting from the initiative. Rationalization actions, in particular standardization and specialization, can have an alliance-strengthening effect. Standardization of systems reduces perceived differences in force capabilities and enhances the capability to structure combined forces. The interdependency of forces is strengthened through specialization. Organization of alliance forces to exploit various national strengths and resources can create a more positive perception of the contribution of all alliance members.

Equity in Distribution of Alliance Expenditures

In assessing this factor, we recommend that consideration be given to the two-way street sales ratio developed by OSD but that the degree of equity perceived by both U.S. and allied decision makers be the major determinant. Perceptions of inequity can reduce support for an RSI initiative and prevent its implementation. Thus, such perceptions are important factors in assessing the value of an initiative. The criterion for the assessment of equity in the distribution of alliance expenditures for materiel and services can also be stated as the ratio of the alliance member's contribution to the alliance expenditures in that country within the current budget cycle. However, there is difficulty in determining what measures to use to estimate a member's contribution. Further, questions arise as to whether expenditures should be distributed equitably by project, over time, in accordance with economic

need, or some other criteria. Because of the absence of universally accepted economic measures, the perceived degree of equity will most likely predominate.

Independent Operations Capability

The independent operations capability is defined as the ability of a U.S. unit to conduct operations outside of the theater(s) affected by the initiative. Rationalization initiatives should be assessed to determine their effect on division equivalent size organizations to perform standard missions in world areas not affected by the initiative. Initiative related to specialization and host nation support may cause the removal of capabilities from the U.S. force structure that are essential for sustained operations in non-alliance areas, or they may increase the ability for independent operations by reducing the amount of integrated support capability required to be deployed with the organization. This capability can be assessed using current U.S. Army models and decision-maker judgment.

CHAPTER 5

APPLICATION OF THE RECOMMENDED MEASURES OF EFFECTIVENESS FOR INTEROPERABILITY INITIATIVES

INTRODUCTION

The battlefield effectiveness of interoperability initiatives should be evaluated under conditions that reflect mobilization, deployment, employment, and sustainment phases of combined force operations and as close to the direct effects of the initiative as possible. Measures of effectiveness must be applied under coalition warfare conditions that assess the contribution of the initiative across all affected functional areas or battlefield operating systems and echelons in the theaters in which the initiative is to be operative.

Analytic tools for European theater scenarios are more advanced than those for other areas and are effective when analyzing the effects of force and weapon system changes in Joint scenarios. The availability of models or other tools to assess communications interoperability initiatives for combined forces is limited. Models that explicitly simulate or evaluate common logistics support in a coalition warfare environment are in various stages of development. Additional work is necessary to adapt available models to address interoperability issues.

GENERAL APPLICATIONS

We selected the measures of effectiveness to reflect operational realities, support decision-making processes, and be usable by both staff and analysis personnel. They should be used with current and developmental models modified to reflect coalition warfare conditions. The measures should be used as criteria for assessing the improvements in effectiveness resulting from interoperability initiatives in command post, field training, Reforger, LOGEX, and similar exercises. They may also be employed in training facilities such as the Army's Warrior Preparation Center when appropriate scenarios are used. Instrumented training applications such as those at the National Training Center would be extremely useful if combined exercises are conducted at those facilities. The measures of effectiveness should be applied in scenarios that evaluate coalition warfare

conditions and whose duration is adequate to stress both U.S. logistics and communications support and those of the other coalition partners. Scenarios should begin with mobilization and proceed through deployment, employment, and sustainment phases of the operation.

COMMUNICATIONS APPLICATIONS

Existing analysis support models should be modified to assess the communications effectiveness under coalition warfare conditions. Although we did not identify any single model as a candidate for such modification, several TRADOC, Concepts Analysis Agency, and commercial models appear to be candidates. We recommend that the requirement for inclusion of coalition warfare communications in model capabilities be stated to the Army analytic community. As an interim measure, the Rationalization, Standardization and Interoperability Policy Office, Office of the Deputy Chief of Staff for Operations and Plans, Headquarters, Department of the Army, should develop a computer-based capability to apply the communications effectiveness criteria we recommend in Chapter 3.

LOGISTICS APPLICATIONS

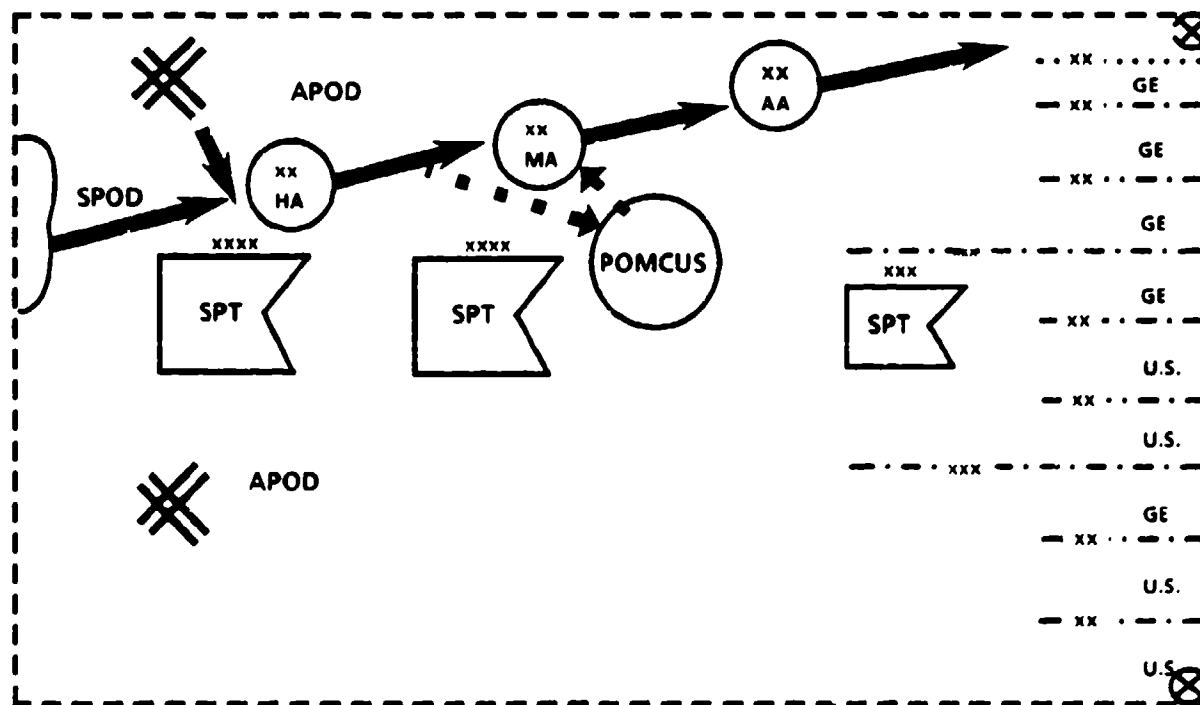
Some existing Army models appear capable of applying the proposed logistics measures of effectiveness. The current FASTALS, FORCEM, and VIC models produce outputs in forms similar to the proposed logistics evaluation criteria, and those outputs can be adapted for BEII use. Current configurations do not appear to be capable of exercising the impact of common logistics support in a coalition warfare setting in sufficient detail to support RSI resource decisions. However, the models have the potential to be modified to accept input data that reflect conditions resulting from various logistics support initiatives and to provide output in forms reflecting the recommended measures of effectiveness.

SCENARIO REQUIREMENTS

We suggest four scenarios for the assessment of interoperability initiatives. They reflect conventional force operations in a mature theater and are not indicative of contingency or special operations which have special interoperability conditions that were not addressed in this study.

Figure 5-1 portrays a pre-positioning of materiel configured to unit sets (POMCUS)-supported U.S. division arriving at sea and air ports of debarkation

(SPOD and APOD), moving to a holding area (HA), marshalling area (MA), assembly area (AA) and relieving a German unit on line. This scenario provides for assessment of the impact of interoperability across all functional areas through all phases of an operation. In particular, it provides a vehicle for assessing rear-area communications and logistics support that may be provided under host nation support initiatives. The number, type, and function of facilities such as holding and marshalling areas may be changed to reflect current doctrine or actual theater conditions. Threat activities in this and other scenarios should be taken from an approved threat verification source.



Note: SPT = Support; GE = German.

FIG. 5-1. RSI SCENARIO (1)

Figure 5-2 portrays a U.S. division in corps reserve deploying from an assembly area to a position between a U.S. division and a West German division.

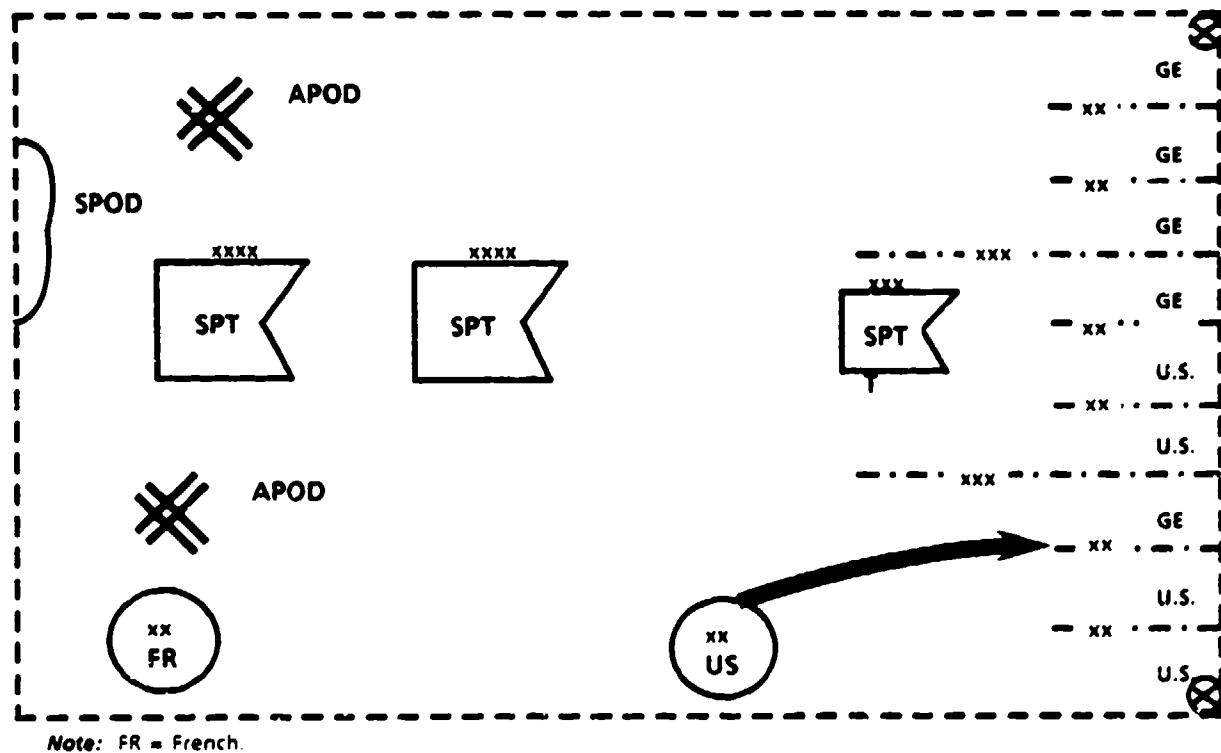


FIG. 5-2. RSI SCENARIO (2)

Figure 5-3 portrays a forward-deployed U.S. division moving laterally across a corps boundary with subsequent employment in an allied corps sector. This scenario places demands on tactical communications interoperability and logistics support.

Figure 5-4 portrays an allied division passing through a U.S. division with whom habitual operating relationships have not previously existed. This scenario exercises all functional area interfaces both at the corps and division levels and should provide opportunities for assessing the impact of alliance-wide interoperability initiatives.

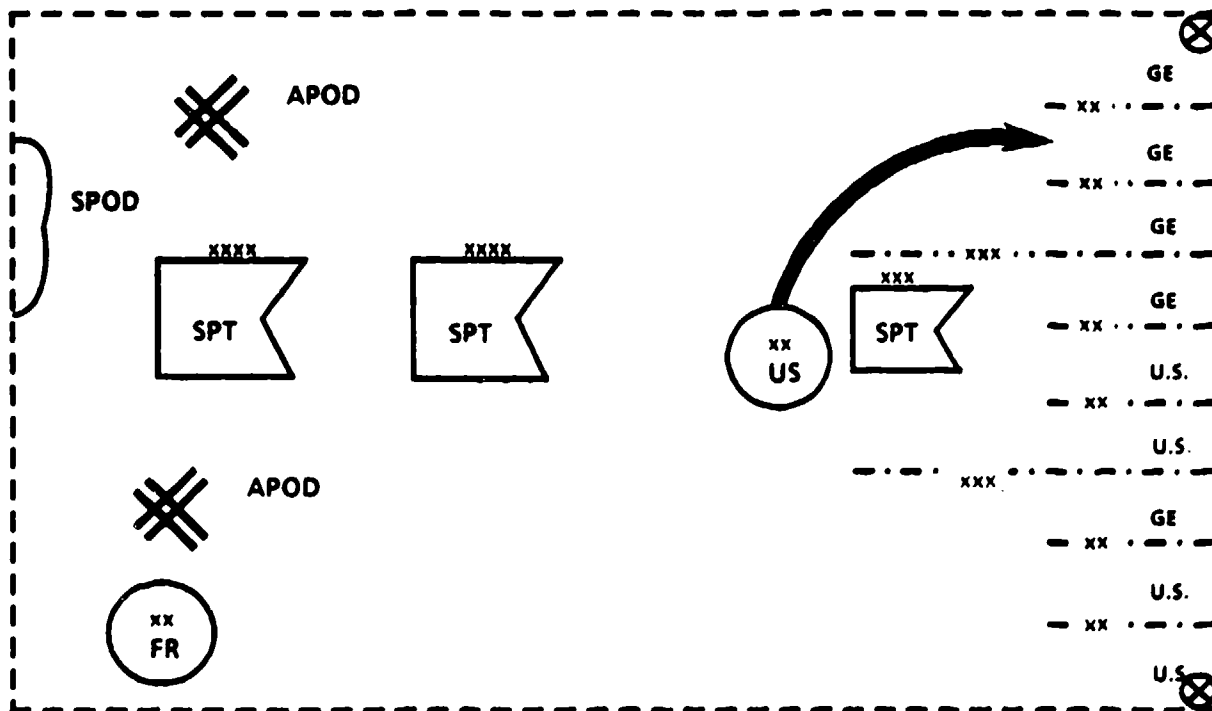


FIG. 5-3. RSI SCENARIO (3)

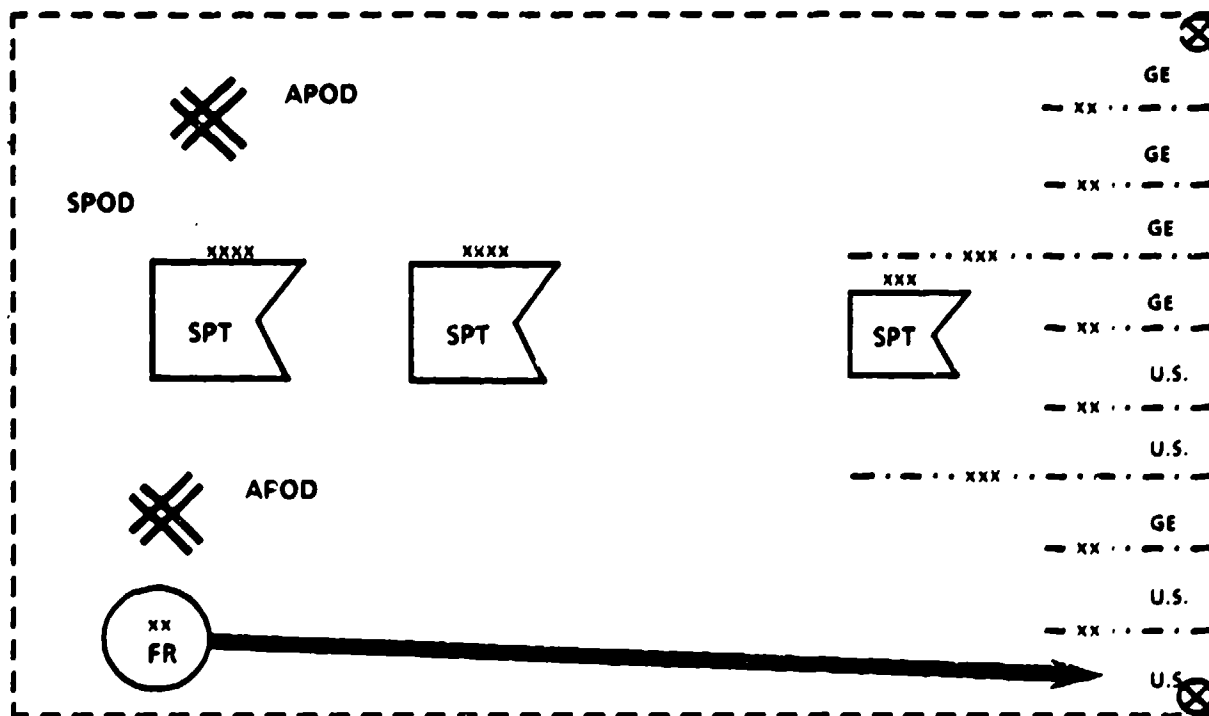


FIG. 5-4. RSI SCENARIO (4)

GLOSSARY

AA	=	assembly area
ABCA	=	America-Britain-Canada-Australia
ABIC	=	Army Battlefield Interface Concept
AD	=	air defense
APOD	=	air ports of debarkation
CINC	=	commander in chief
FLOT	=	forward-line-of-own-troops
FS	=	fire support
HA	=	holding area
IOC	=	initial operational capability
LOG	=	logistics
LMI	=	Logistics Management Institute
MA	=	marshalling area
MOEs	=	measures of effectiveness
MSE	=	mobile subscriber equipment
ODCSOPS	=	Office of the Deputy Chief of Staff for Plans and Operations
POMCUS	=	pre-positioning of materiel configured to unit sets
RSI	=	rationalization, standardization, and interoperability
RSI-BEII	=	rationalization, standardization, and interoperability battlefield effectiveness improvement index
SPOD	=	sea ports of debarkation
STANAGS	=	standardization agreements

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APPENDIX A

RELATIONSHIPS AMONG RATIONALIZATION, STANDARDIZATION, AND INTEROPERABILITY

INTRODUCTION

Rationalization, standardization, interoperability (RSI) are defined in Joint Chiefs of Staff, *JCS Pub 1*; Draft Army Regulation 34-1, *International Rationalization, Standardization, and Interoperability (RSI)*; and several other publications. None of the definitions provides an easy understanding of the concept of RSI. This appendix defines the relationships among rationalization, standardization, and interoperability used in this study, the level at which each is of primary concern, and the apparent decision-making levels. These levels are important in that they indicate where the measures of effectiveness should be applied.

RATIONALIZATION

Rationalization is any action that increases the effectiveness of allied/alliance forces through more efficient or effective use of defense resources committed to the alliance. Rationalization includes consolidation, reassignment of national priorities to alliance needs, standardization, specialization, mutual support or improved interoperability, and greater cooperation. Rationalization applies to both weapons/materiel resources and nonweapons military matters. (AR 34-1 Draft)

The use of the words "more efficient or effective use" seems to indicate a choice of desired results. For purposes of this study, the desired results are stated as being *efficient and effective* use of defense resources. The term "consolidation" is not further defined and is interpreted to mean uniting resource allocation systems or facilities.

In this definition, improved interoperability and standardization are included as elements of rationalization. Interoperability is also perceived to be a degree of standardization or an effect of the standardization process. Our study defines interoperability as a degree of standardization or a result of standardization

initiatives and not as an element of rationalization. Figure A-1 graphically depicts the elements of rationalization as used in our development of measures of effectiveness for RSI. It portrays consolidation, reassignment of priorities, standardization, specialization, and mutual support as components of rationalization. It also indicates that actions outside the rationalization arena such as the perceived threat, national economics, technology, and operational concepts for the forces involved have an effect on determining the degree of standardization achieved within the alliance.

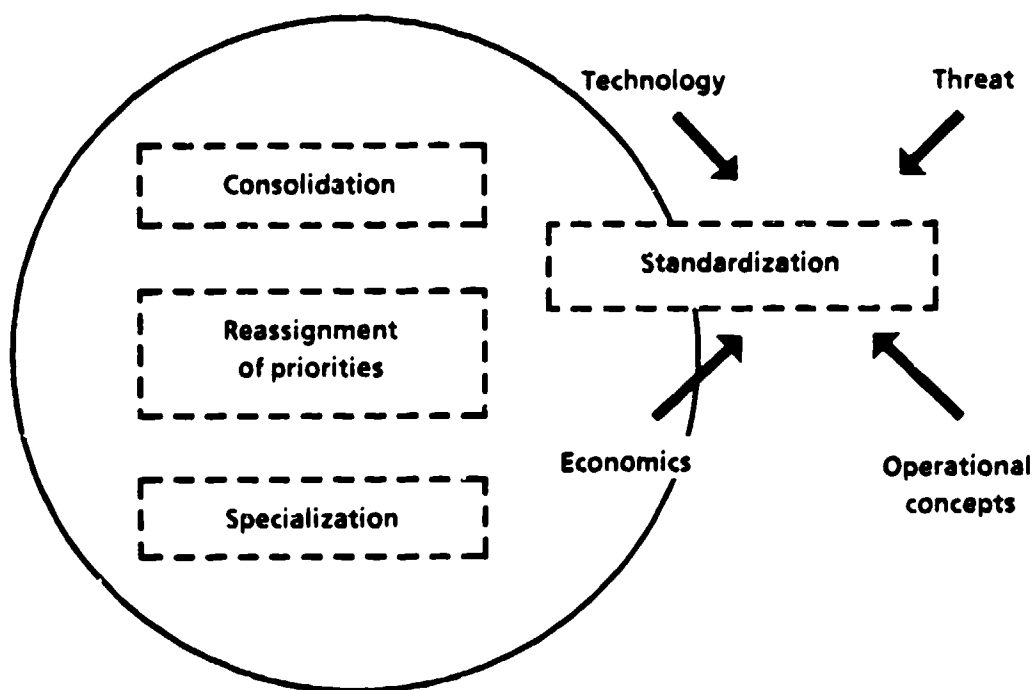


FIG. A-1. RATIONALIZATION COMPONENTS

Rationalization actions appear to be primarily of interest at the strategic levels of warfare, involve political and economic decisions at the alliance and national levels, and are directed towards efficiency and effectiveness of forces and improving alliance strength. The effects of rationalization appear to be more qualitative than quantitative. Consequently, the rationalization-specific measures of effectiveness are stated in qualitative terms and include standardization measures of effectiveness.

STANDARDIZATION

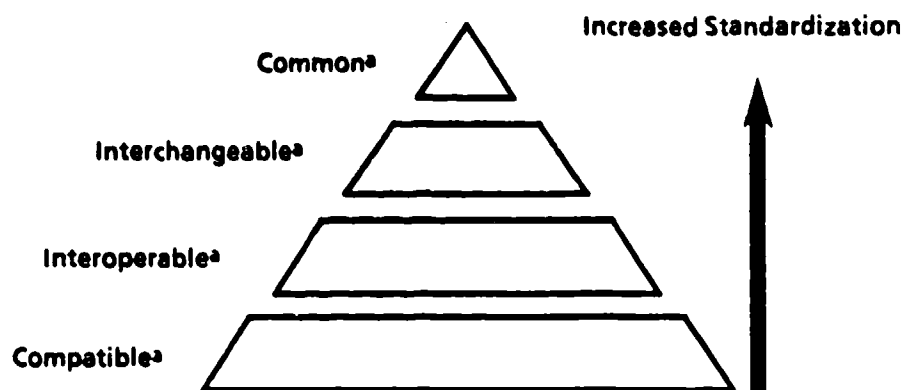
Standardization is the process by which nations achieve the closest practicable degree of cooperation among forces; make the most efficient use of research, development, and production resources; and agree, on the broadest possible basis, on the use of common or compatible procedures, items, and doctrine. The latter include (1) common or compatible operational, administrative, and logistic procedures; (2) common or compatible technical procedures and criteria; (3) common, compatible, or interchangeable supplies, components, weapons, or equipment; and (4) common or compatible tactical doctrine with corresponding organizational compatibility. It encompasses the process of developing concepts, doctrine, procedures, and designs to achieve and maintain the most effective levels of compatibility, interoperability, interchangeability, and commonality in the fields of operations, administration, and material. (AR 34-1 Draft)

For purposes of this study, we used the latter part of this definition: "... the process of developing concepts, doctrine, procedures, and designs to achieve and maintain the most effective levels of compatibility, interoperability, interchangeability, and commonality in the fields of operations, administration, and material." This portion of the definition appears to capture the meaning of standardization as understood by most of the participants in this study. Standardization, as previously stated, is considered a rationalization action and a product of other factors. Figure A-2 portrays the elements and degrees of standardization based on this view of the concept. ~

While standardization is of interest at all levels of warfare, standardization decisions are usually made at alliance and national levels. Since some standardization effects are quantitative and others are qualitative, the standardization-specific measures of effectiveness are stated in those terms. Standardization measures of effectiveness also include interoperability measures of effectiveness.

INTEROPERABILITY

Interoperability is the ability of systems, units or forces to provide services to and accept services from other systems, units or forces and to use the services to enable them to operate effectively together. (AR 34-1 Draft)



^a Operations, administration, and personnel.

FIG. A-2. STANDARDIZATION COMPONENTS

That definition does not include the ability of the various functional areas or battlefield operational systems to exchange information and to execute battlefield events cooperatively. The concept of interoperability used in this study to identify effectiveness criteria includes these requirements. The AR 34-1 (Draft) definition addresses only systems and forces components, while this study includes a doctrine and tactics component in the interoperability concept. Doctrine and tactics must support interoperability at force and system levels to maximize the effects of an interoperability initiative. Figure A-3 portrays the interrelationship of systems, forces, and doctrine and tactics.

Improved interoperability is the predominant requirement from RSI initiatives for tactical commanders. Rationalization and standardization are viewed as means of achieving satisfaction of that requirement. Interoperability initiatives most directly affect battlefield effectiveness. They produce results that, in general, are quantifiable.

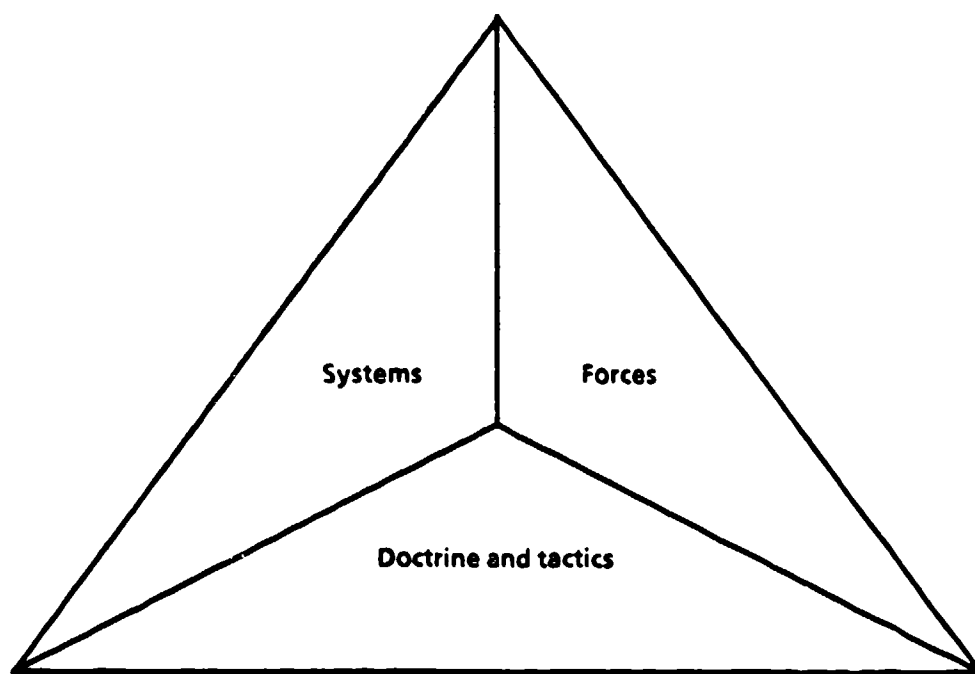


FIG. A-3. INTEROPERABILITY COMPONENTS

APPENDIX B

INTEROPERABILITY ISSUES AND EFFECTIVENESS CRITERIA

INTRODUCTION

The identification of interoperability measures of effectiveness was influenced by interoperability issues that evolved during the the data collection process for this study. The selection of the assessment criteria was based in part on that solicited from operational and tactical commanders, combat developers, standardization groups, and NATO agencies. This appendix discusses the most critical interoperability issues and assessment criteria of the Army personnel who were interviewed during the course of this study.

INTEROPERABILITY ISSUES

Communications Interoperability

Communications interoperability is currently the paramount rationalization, standardization, and interoperability (RSI) issue of commanders, combat developers, standardization staffs, and NATO agencies. The impact of the noninteroperability of newer combat net radios and associated communications security systems is of particular concern. The need to achieve interoperability of mobile subscriber equipment (MSE) is also of concern.

The inability of lateral functional or mission area support systems to establish communications rapidly creates delays in passing critical information, especially in the command-and-control, fire support, air defense, and mobility/countermobility areas. Noninteroperability of communications systems has created a requirement to place liaison personnel and equipment at several echelons and functional areas as a temporary remedial measure.

Ammunition Interoperability

The ability of combined forces to use the same ammunition is the second interoperability concern of commanders and combat developers. Large caliber ammunition such as 155-millimeter artillery rounds and main tank rounds are the

most critical. The ability of commanders to plan operations and equalize ammunition supplies across forces is facilitated by ammunition interoperability.

Common Consumables

The use of common consumables would greatly enhance the task organization and mutual support of forces. Tactical and operational commanders identify this requirement as third in their current interoperability needs.

Skills Transferability

Skills transferability, or the ability of personnel of nations to operate systems of other nations, such as main battle tanks and artillery pieces, is a desired capability. Common or similar system configurations, operating procedures, and training would improve battlefield interoperability.

Services Deficiencies

Provision of services by host nation or allied services organizations would overcome some of the shortfalls in the U.S. force structure, particularly in the early phases of a European war. Services shortfalls are of concern to both operational and tactical commanders and logisticians.

Medical Support

Use of host nation or allied medical support, in particular medical facilities and supplies, is also an issue that can be resolved through RSI initiatives, with consequential improvement in force battlefield effectiveness.

Joint Issues

The resolution of interoperability issues in Joint communications is considered a major RSI challenge to be confronted with equal or greater urgency than combined communications.

Other Issues

The focus of other issues was influenced significantly by echelon, function, and responsibilities of the personnel interviewed. Some other issues were: out-of-sector combat service support; ability to adhere to existing standardization agreements (STANAGS); civilian support in wartime; common test, measurement, and

diagnostic equipment; metric-versus-linear measurement of tools; interfaces between manual and automated equipments; communications security; interoperability training; decontamination procedures; exploitation of local industrial base; and software development and use.

CRITERIA

The criteria of the various commanders and staffs contained in this section are a consolidation of the responses elicited during interviews. They reflect the criteria that commanders and staffs indicated they would use to evaluate the effectiveness of RSI initiatives with reference to battlefield effectiveness. The instruments used in the criteria collection process are presented in Appendix C.

Mission Accomplishment

This criterion involves the effects of the initiative on the accomplishment of the unit's mission. It was also stated as the degree of satisfaction of mission area requirements.

Critical Function Performance

This criterion involves the effects of the RSI initiative on the time required to execute, or the degree of performance of, critical battlefield functions or operations such as target engagement, planning, training, command decision making, and sustainment actions. This criterion is closely related to the mission accomplishment criterion.

Reconstitution Capability

This criterion involves the change in the capability to regenerate or reorganize forces after sustained combat, heavy losses, and massive destruction of equipment. It also involves the capability to restore ineffective forces to a specified level of combat readiness.

Personnel Requirements

This criterion involves the impact of the RSI initiative on the number of personnel required. It was also stated in terms of U.S. personnel only.

Unit Readiness

This criterion involves the effects of the RSI initiative on the readiness of the unit to perform its wartime function. It was generally stated in terms of readiness of personnel and mission essential equipment.

Logistics Burden

Logistics burden is the change in logistics support requirements as a consequence of the initiative. This criterion was also stated as inventory requirements and supporting force requirements.

Support-to-Combat Ratio

This criterion involves the ratio of personnel designated as support to those designated as combat or supported personnel. It includes the effects of transfer of support functions to non-U.S. military and civilian entities and to contractor organizations.

Resource Allocation Ability

This criterion involves the ability of a commander to allocate forces, systems, and supplies as affected by the RSI initiative.

Loss/Attrition Rates

This criterion involves the changes in the expected ratio between friendly and enemy personnel and system losses that can be attributed to the RSI initiative.

Return-to-Duty Rates

The return-to-duty rates criterion involves the average time from the occurrence of casualties to the return to duty of a specified percentage of personnel. It may also be stated as the percentage of personnel who become casualties and are returned to duty within a specified time.

Flexibility, Redundancy, and Efficiency

This criterion involves the increase in survivability, speed of service, and efficiency in use of personnel and systems that can be attributed to the RSI initiative, particularly with regard to communications.

Initiative

This criterion involves the improvement in a commanders ability to set or change the terms of battle by action.

Agility

The agility criterion is the improvement in the ability of forces to act faster than the enemy.

Depth

The depth criterion is the improvement in the ability of the force to extend operations in terms of space, time, and resources.

Synchronization

The synchronization criterion is the improvement in the ability to produce maximum relative combat power at the decisive point through the arrangement of battlefield activities in time, space, and purpose.

Other Criteria

In addition to the above criteria, assessment criteria proposed by the personnel interviewed included; decision quality, command post operating efficiency, cost, degree of satisfaction of concept-based requirements, percent of critical cargo moved, time to plan operations, ability to allocate resources, capital investment, loss ratios, air sortie generation capability, degree of risk, sustainability, alliance health, time to introduce new technology, and technology gain.

APPENDIX C

DATA-GATHERING INSTRUMENTS

DATA COLLECTION FORMS

Forms used in solicitation of rationalization, standardization, and interoperability (RSI) issues, the assessment criteria, and the measures of effectiveness (MOEs) currently in use are presented in this appendix along with the questionnaire used to develop the weighted values of the recommended measures of effectiveness.

DATA-COLLECTION FORM

DATE

LOCATION

PERSON
INTERVIEWED

TITLE

__/__/__

AREA OF INTEREST COMMUNICATIONS

SUBAREA MEASURES OF EFFECTIVENESS (MOE)
IN USE

Question

Response (If necessary use separate sheet)

What MOE are
currently used to
evaluate common systems?

How are the MOE
defined?

How were the MOE
developed?

How are the MOE
applied? (model,
etc.)

Do MOE differ by
echelon/system/
functional area?

If so how?

Are any of the MOE
RSI specific?

DATA-COLLECTION FORM

DATE	LOCATION	PERSON INTERVIEWED	TITLE
__/__/__	_____	_____	_____

AREA OF INTEREST	COMMON LOGISTICS (LOG) SUPPORT
SUBAREA	MEASURES OF EFFECTIVENESS (MOE)
	IN USE

Question

Response (If necessary use separate sheet)

What MOE are currently
used to evaluate LOG systems?

How are the MOE defined?

How were the MOE
developed?

How are the MOE applied?
(model, etc)

Do MOE differ by echelon/
system/functions area/or
log component such as trans,
med, maint, or supply?

If so how?

Are any of the MOE RSI-
specific?

DATA-COLLECTION FORM

DATE	LOCATION	PERSON INTERVIEWED	TITLE
__/__/__	_____	_____	_____

AREA OF INTEREST	DOCTRINE AND TACTICS
SUBAREA	MEASURES OF EFFECTIVENESS (MOE) IN USE

Question

Response (If necessary use separate sheet)

What MOE are
currently used to
evaluate changes in
doctrine and tactics?

How are the MOE defined?

How were the MOE
developed?

How are the MOE applied?
(model, etc)

Do MOE differ by
echelon/system/functional
area?

If so how?

Are any of the MOE
RSI-specific?

DATA-COLLECTION FORM

DATE	LOCATION	PERSON INTERVIEWED	TITLE
<u> / / </u>	<u> </u>	<u> </u>	<u> </u>

AREA OF INTEREST	COMMUNICATIONS
SUBAREA	PROGRAMS IN DEVELOPMENT

Question

Response (If necessary use separate sheet)

What communications systems are in development which will have significant battlefield impact?

What are their Initial Operational Capabilities (IOCs)?

Which of these are in a cooperative development program?

Why were they chosen?

Why were the others not chosen?

What NATO doctrinal issues were considered?

DATA-COLLECTION FORM

DATE	LOCATION	PERSON INTERVIEWED	TITLE
__/__/__	_____	_____	_____

AREA OF INTEREST LOGISTICS

SUBAREA PROGRAMS IN DEVELOPMENT

Question

Response (If necessary use separate sheet)

What logistics systems (trans, med, maint, supply) are in development which will have significant battlefield impact?

What are their IOCs?

Which of these are in a cooperative development program?

Why were they chosen?

Why were the others not chosen?

What NATO doctrinal or tactics issues were considered?

DATA-COLLECTION FORM

DATE	LOCATION	PERSON INTERVIEWED	TITLE
<u> / / </u>	<u> </u>	<u> </u>	<u> </u>

AREA OF INTEREST	COMMUNICATIONS
SUBAREA	CRITERIA FOR EFFECTIVENESS

Question

Response (If necessary use separate sheet)

What are you personal
criteria for
battlefield
effectiveness of
communications
system?

What criteria would
you use to
ascertain the
battlefield
effectiveness of:
Combat net radio?
Mobile subscriber equipment (MSE)?
Multichannel systems?
SATCOM
Switching systems?
Data distribution systems?

How would these
criteria vary –
by echelon?
by functional area?
by operation?

Which of the
following criteria
would you use?

Air/land/space
control.
Personnel required.
Systems required.
Cost.

Time to perform a
function (specify).
Personnel losses.
Unit losses.
System losses.

Reliability.
Flexibility.
Combat
effectiveness.
Facilities required.

DATA-COLLECTION FORM

DATE	LOCATION	PERSON INTERVIEWED	TITLE
__/__/__	_____	_____	_____

AREA OF INTEREST LOGISTICS

SUBAREA CRITERIA FOR EFFECTIVENESS

Question

Response (If necessary use separate sheet)

What are your
personal criteria
for battlefield effectiveness
of logistics systems?

What criteria would you use
to ascertain the battlefield
effectiveness of common
logistics support?
In medical support?
In transportation support?
In maintenance support?
In supply support?

How would these criteria vary –
by echelon?
by functional area?

Which of the following
criteria would you use?

Air/land/space
control.
Personnel required.
Unit condition.
Systems required.
Cost.

Time to perform a
function (specify).
Personnel losses.
Unit losses.
System losses.
Availability.

Reliability.
Flexibility.
Combat
effectiveness.
Facilities required.
Supporting-to-supported
ratio.

DATA-COLLECTION FORM

DATE	LOCATION	PERSON INTERVIEWED	TITLE
<u> / / </u>	<u> </u>	<u> </u>	<u> </u>

AREA OF INTEREST DOCTRINE/TACTICS

SUBAREA CRITERIA FOR EFFECTIVENESS

Question

Response (If necessary use separate sheet)

What are your
personal criteria
for battlefield
effectiveness of doctrine
and tactics?
How would these criteria vary --
by echelon?
by functional area?
by operation?

Which of the following criteria
would you use?

Air/land/space
control.
Personnel required.
Systems required.
Support requirements.
Cost.

Time to perform a
function (specify).
Personnel losses.
Unit losses.
System losses.
Availability.

Planning time.
Training time.
Execution time.
Combat
effectiveness.
Supporting-to-supported
ratio.

DATA-COLLECTION FORM

DATE	LOCATION	PERSON INTERVIEWED	TITLE
<u> / / </u>	<u> </u>	<u> </u>	<u> </u>

AREA OF INTEREST	LOGISTICS
SUBAREA	CURRENT INTEROPERABILITY PROGRAMS

Question

Response (If necessary use separate sheet)

What logistics system
(transportation, medical,
maintainance, or supply)
interoperability
programs have been
undertaken or are
in development
that will have
significant
battlefield impact?

What are their
schedules?

Why were they
chosen?

What criteria were
used in selecting
them?

What NATO doctrinal
or tactics issues
were considered?

DATA-COLLECTION FORM

DATE	LOCATION	PERSON INTERVIEWED	TITLE
__/__/__	_____	_____	_____

AREA OF INTEREST	COMMUNICATIONS
SUBAREA	CURRENT INTEROPERABILITY PROGRAMS

Question

Response (If necessary use separate sheet)

What communications
interoperability
programs are
currently in
development that
will have
significant
battlefield impact?

What are their
schedules?

Why were they
chosen?

What criteria were
used in selecting
them?

What NATO doctrinal
issues were considered?

DATA-COLLECTION FORM

DATE

__/__/__

LOCATION

PERSON
INTERVIEWED

TITLE

AREA OF INTEREST DOCTRINE AND TACTICS

SUBAREA CURRENT INTEROPERABILITY
PROGRAMS

Question

Response (If necessary use separate sheet)

What doctrine and
tactics related
programs are
currently in
development that
will have
significant
battlefield impact?

What are their
schedules?

Why were they
chosen?

What criteria were
used in selecting
them?

What NATO doctrinal
issues were considered?

DATA-COLLECTION FORM

DATE

__/__/__

LOCATION

PERSON
INTERVIEWED

TITLE

AREA OF INTEREST COMMUNICATIONS

SUBAREA CURRENT INTEROPERABILITY ISSUES

Question

Response (If necessary use separate sheet)

What communications
interoperability
issues or problems
currently exist
that have
significant
battlefield impact?

How do these affect
battlefield
effectiveness?

How would you
assess the
effectiveness of
potential solutions
to these issues?

What criteria
would you use in
assessing
solutions?

DATA-COLLECTION FORM

DATE	LOCATION	PERSON INTERVIEWED	TITLE
__/__/__	_____	_____	_____

AREA OF INTEREST LOGISTICS

SUBAREA CURRENT INTEROPERABILITY ISSUES

Question

Response (If necessary use separate sheet)

What logistics systems
(transportation, medical,
maintenance, or supply)
issues or
problems exist that
have significant
battlefield impact?

How do these affect
battlefield
effectiveness?

How would you
assess the
effectiveness of
potential solutions
to these issues?

What criteria
would you use in
assessing potential
solutions?

DATA-COLLECTION FORM

DATE	LOCATION	PERSON INTERVIEWED	TITLE
__/__/__	_____	_____	_____

AREA OF INTEREST	DOCTRINE AND TACTICS
SUBAREA	CURRENT INTEROPERABILITY ISSUES

Question

Response (If necessary use separate sheet)

What doctrine and tactics interoperability issues or problems exist that have significant battlefield impact?

How do these affect battlefield effectiveness?

How would you assess the effectiveness of potential solutions to these issues?

What criteria would you use in assessing potential solutions?

PAIRWISE COMPARISON PROCESS FOR MEASURES OF EFFECTIVENESS

You are being asked to use your military judgment to assist in the weighting of a set of measures of effectiveness that are being recommended as elements of an RSI battlefield effectiveness improvement index. This index development effort is currently limited to initiatives that involve communications interoperability and common logistics support. The index is being proposed as a method for comparing RSI initiatives for the purposes of policy formulation and resource allocation. To assist in the development of the weights, you are asked to make a pairwise comparison of six different measures of effectiveness and indicate the degree of importance of each. The following scale defines degrees of importance to assist you in making your evaluation as to the degree of importance of one measure of effectiveness over another.

Degree of Importance	Definition
1	Equal importance. MOE are equal as indicators of battlefield effectiveness of an RSI initiative.
3	Weak importance of this measure as an indicator of battlefield effectiveness of an RSI initiative over the other. Experience and judgment slightly favor this measure over the other.
5	The measure is a strong indicator of RSI battlefield effectiveness over the other. Experience and judgment strongly favor its measure over the other.
7	This measure has demonstrated importance over the other as an indicator of battlefield effectiveness. It is strongly favored and has been accepted in practice to be a dominant indicator.
9	This measure is of absolute importance over the other. The evidence favoring this measure over the other is of the highest possible order of affirmation.

To start the process, begin with the first pair of measures of effectiveness, improvement in functional area performance and personnel savings, and evaluate from a battlefield effectiveness perspective which of these two is dominant or more important. Then determine to what degree the measure is dominant or more important than the other and circle a value 1 through 9. If a measures' degree of importance over another is considered to be an intermediate value between two judgments, circle the even number that lies between the two values.

For example, if in comparing improvement in functional area performance (communications) and personnel savings, you judged personnel savings to be more important, you would then go to the "personnel savings over functional area performance line." If you consider the degree of importance to be weak, then you should circle number 3 on that line. If you consider the importance to be an intermediate value between weak importance and strong importance, then you should circle number 4. Please proceed through each pair of comparisons, first selecting the measures of effectiveness that is dominant and then identifying the degree to which it is dominant.

Communications performance improvement over Personnel savings	1	2	3	4	5	6	7	8	9
---	---	---	---	---	---	---	---	---	---

Personnel savings over Communications performance improvement	1	2	3	4	5	6	7	8	9
---	---	---	---	---	---	---	---	---	---

Communications performance improvement over System savings	1	2	3	4	5	6	7	8	9
--	---	---	---	---	---	---	---	---	---

System savings over Communications performance improvement	1	2	3	4	5	6	7	8	9
--	---	---	---	---	---	---	---	---	---

Communications performance improvement over Decrease in supporting-to-supported ratio	1	2	3	4	5	6	7	8	9
---	---	---	---	---	---	---	---	---	---

Decrease in supporting-to-supported ratio over Communications performance improvement	1	2	3	4	5	6	7	8	9
---	---	---	---	---	---	---	---	---	---

Communications performance improvement over Reconstitution capability improvement	1	2	3	4	5	6	7	8	9
---	---	---	---	---	---	---	---	---	---

Reconstitution capability improvement over Communications performance improvement	1	2	3	4	5	6	7	8	9
---	---	---	---	---	---	---	---	---	---

Communications performance improvement over Satisfaction of CINCs' priority	1	2	3	4	5	6	7	8	9
---	---	---	---	---	---	---	---	---	---

Satisfaction of CINCs' priority over Communications performance improvement	1	2	3	4	5	6	7	8	9
---	---	---	---	---	---	---	---	---	---

Personnel savings over Systems savings	1	2	3	4	5	6	7	8	9
--	---	---	---	---	---	---	---	---	---

Systems savings over Personnel savings	1	2	3	4	5	6	7	8	9
--	---	---	---	---	---	---	---	---	---

Personnel savings over Decrease in supporting-to-supported ratio	1	2	3	4	5	6	7	8	9
--	---	---	---	---	---	---	---	---	---

Decrease in supporting-to-supported ratio over Personnel savings	1	2	3	4	5	6	7	8	9
--	---	---	---	---	---	---	---	---	---

Personnel savings over Reconstitution capability improvement	1	2	3	4	5	6	7	8	9
--	---	---	---	---	---	---	---	---	---

Reconstitution capability improvement over Personnel savings	1	2	3	4	5	6	7	8	9
--	---	---	---	---	---	---	---	---	---

Personnel savings over Satisfaction of CINCs' priorities	1	2	3	4	5	6	7	8	9
--	---	---	---	---	---	---	---	---	---

Satisfaction of CINCs' priorities over Personnel savings	1	2	3	4	5	6	7	8	9
--	---	---	---	---	---	---	---	---	---

Reconstitution capability improvement over Satisfaction of CINCs' priorities	1	2	3	4	5	6	7	8	9
--	---	---	---	---	---	---	---	---	---

Satisfaction of CINCs' priorities over Reconstitution capability improvement	1	2	3	4	5	6	7	8	9
--	---	---	---	---	---	---	---	---	---

Systems savings over Decrease in supporting-to-supported ratio	1	2	3	4	5	6	7	8	9
Decrease in supporting-to-supported ratio over Systems savings	1	2	3	4	5	6	7	8	9

Systems savings over Reconstitution capability improvement	1	2	3	4	5	6	7	8	9
Reconstitution capability improvement over Systems savings	1	2	3	4	5	6	7	8	9

Systems savings over Satisfaction of CINCs' priorities	1	2	3	4	5	6	7	8	9
Satisfaction of CINCs' priorities over Systems savings	1	2	3	4	5	6	7	8	9

Decrease in supporting-to-supported ratio over Reconstitution capability improvement	1	2	3	4	5	6	7	8	9
Reconstitution capability improvement over Decrease in supporting-to-supported ratio	1	2	3	4	5	6	7	8	9

Decrease in supporting-to-supported ratio over Satisfaction of CINCs' priorities	1	2	3	4	5	6	7	8	9
Satisfaction of CINCs' priorities over Decrease in supporting-to-supported ratio	1	2	3	4	5	6	7	8	9

Logistics performance improvement over Personnel savings	1	2	3	4	5	6	7	8	9
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Personnel savings over Logistics performance improvement	1	2	3	4	5				9
--	---	---	---	---	---	--	--	--	---

Logistics performance improvement over System savings	1	2	3	4	5	6	7	8	9
---	---	---	---	---	---	---	---	---	---

System savings over Logistics performance improvement	1	2	3	4	5	6	7	8	9
---	---	---	---	---	---	---	---	---	---

Logistics performance improvement over Decrease in supporting-to-supported ratio	1	2	3	4	5	6	7	8	9
--	---	---	---	---	---	---	---	---	---

Decrease in supporting-to-supported ratio over Logistics performance improvement	1	2	3	4	5	6	7	8	9
--	---	---	---	---	---	---	---	---	---

Logistics performance improvement over Reconstitution capability improvement	1	2	3	4	5	6	7	8	9
--	---	---	---	---	---	---	---	---	---

Reconstitution capability improvement over Logistics performance improvement	1	2	3	4	5	6	7	8	9
--	---	---	---	---	---	---	---	---	---

Logistics performance improvement over Satisfaction of CINCs' priority	1	2	3	4	5	6	7	8	9
--	---	---	---	---	---	---	---	---	---

Satisfaction of CINCs' priority over Logistics performance improvement	1	2	3	4	5	6	7	8	9
--	---	---	---	---	---	---	---	---	---

DEFINITIONS

Functional area performance: The degree of improvement in meeting mission essential requirements within a given functional area, e.g., air defense, fire support, C2. It considers the contribution and value by functional area, echelon, and activity. For example, communications for fire support would include the value of each echelon, the value of fire support, and the degree to which fire support communications requirements are improved at each echelon.

Personnel savings: Decrease in personnel requirements as a consequence of the initiative.

Supporting-to-supported ratio: The ratio of personnel identified as support to personnel performing combat functions.

Systems savings: The dollar value of systems saved as a result of the initiative. May also be stated as the sum of the weighted value of the system multiplied by the number of systems saved, by type.

Satisfaction of CINCs' priorities: The degree to which the RSI priorities of the commanders in chief are satisfied.

Reconstitution capability: The number of battalions restored to combat effectiveness, as a consequence of regeneration, from U.S. and alliance resources.

APPENDIX D
COMMANDS AND AGENCIES VISITED AND PERSONNEL
INTERVIEWED

**Headquarters, U.S. Army Training
and Doctrine Command**

COL Kinsey	MAJ Rice
COL McKimmey	MAJ Rider
LTC Banks	MAJ Twitero
LTC Beckno	Mr. Christiansen
LTC Burckard	Mr. Dooley
LTC Frilak	Mr. Gargaro
LTC Linthwaite	Mr. Rada
MAJ Bottom	Mr. Thompson

U.S. Army Logistics Center

LTC Johnson	Mr. Wilson
Mr. Bodin	Mr. Wund

U.S. Army Signal Center

COL Holman	CPT Bowman
MAJ Beaty	Mr. Parelerlei
MAJ Mourfield	

Headquarters, U.S. Army Europe

General G. Otis	LTC Hines
MG Joulwan	MAJ Mitchell
MG Rozier	MAJ Rauen
COL Acinapura	

21st Support Command

LTC Wignall
LTC Milner
MAJ Laneurs

MAJ Katolik
SFC McMullen

Headquarters, V Corps

LTC Beckman
LTC Keown
LTC Powl
MAJ Bobbitt

MAJ Rearden
MAJ Rockwell
CPT Shirk
Mr. Wolpers

Headquarters, VII Corps

MAJ Cluck
MAJ Ellis
MAJ Giles

MAJ Tibbs
MAJ Walton

Headquarters, 3D Infantry Division (M)

COL Haupt
LTC Banisch
LTC Thompson
MAJ Clements
MAJ Kalb
MAJ Pharis

MAJ Thomas
CPT Bech
CPT Jordan
CPT Westwood
LT Gallagher

Headquarters, 3D Armored Division

COL Beale
LTC Alexander

LTC Hespy
MAJ Clarke

U.S. Army Research, Development and Standardization Group, Bonn

COL Weichel

LTC Corn

U.S. Mission NATO

COL Osborne
COL Smith
LTC Sendak

MAJ Brand
MAJ Brew

**Supreme Headquarters Allied Powers
Europe (SHAPE)**

COL Hanley
COL Ross
COL Solli
COL Tudor

CDR Lachlan
MAJ Heidema
MAJ Seay

**NATO Maintenance and Supply Agency
(NAMSA)**

Mr. Anderson
Mr. Broecker
Mr. Caldwell
Mr. Christiansen

Mrs. Goeller
Mr. Jansen
Mr. Martin
Mr. Wheat

APPENDIX E

BATTLEFIELD EFFECTIVENESS IMPROVEMENT INDEX (BEII)

WORKSHEET

BATTLEFIELD EFFECTIVENESS IMPROVEMENT INDEX

1	2	3	4	5	6	7
ATTRIBUTE NAME	BASE CASE PERFORMANCE	INITIATIVE PERFORMANCE	IMPROVE- MENT	EFF _{xxx} (4/2)	MOE WEIGHT	(5X6)
Functional area effectiveness						
Personnel requirements						
Systems costs						
Supporting- to-supported ratio						
Reconstitution Capability						
CINCs' priorities	XXX					
Initiative BEII						

BEII WORKSHEET INSTRUCTIONS

1. In Column 2, enter the base case values for each effectiveness category except CINCs' priorities.
2. In Column 3, enter the initiative values for each effectiveness category.
3. Subtract the value for functional area effectiveness and reconstitution capability in Column 2 from the corresponding category in Column 3, and enter the difference in Column 4. Subtract the value for personnel requirements, systems costs, and supporting force in Column 3 from the corresponding value in Column 2, and enter differences in the corresponding row in Column 4. Column 4 now shows the improvement for each attribute as a result of the initiative. *Note:* Until a methodology is established for determining the degree of satisfaction of the CINCs' priorities, the relative priority should be used for comparison purposes.
4. Divide the value in Column 4 by the corresponding row value in Column 2, and enter the value as a decimal in Column 5. Enter the initiative's weighted priority with respect to the CINCs' priorities in column 5 of the CINCs' priorities row of the matrix. Column 5 now contains the EFFxxx value.
5. Enter the MOE weight in Column 6.
6. Multiply the EFFxxx value in Column 5 by the corresponding MOE weight in column 6, and enter the value in Column 7.
7. Sum the values in Column 7 to arrive at the initiative BEII. The BEII should be a value between -1 and +1. The base case value would be 0.